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Status of Atlantic salmon (*Salmo salar* L.) in Campbellton River, Notre Dame Bay (SFA 4), Newfoundland in 2000

État du stock de saumon atlantique (*Salmo salar* L.) de la rivière Campbellton et de la baie Notre-Dame (SPS 4), à Terre-Neuve, en 2000

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Abstract

The status of Atlantic salmon in Campbellton River in 2000 was determined from the number of salmon counted through a portable fish counting weir (fence) located on the main stem just above head of the tide and from biological data collected at the fence site and from the recreational fishery. One aspect of stock status is defined in comparison of the actual egg deposition to conservation requirements. In 2000, adult returns were 1,789 small and 208 large salmon, which is lower when compared to the average of 3,061 small and 333 large salmon from 1993-99. Historical records indicated that circa.1800, about 12,000 adult salmon were captured at a harvesting weir. The freshwater survival from eggs to smolt for the 1993 to 1995 year classes were 0.69%, 0.71% and 0.51%, respectively and the mean smolt to grilse survival for the years 1993 to 1999 is 4.95%. The percent of the conservation egg requirement achieved for Campbellton River in 2000 was 157% (95th CI=125 to 175). On average, for the period of 1993-2000, Campbellton River achieved 267% of its conservation requirement. Returns to Campbellton River in 2000 were less than 30% of historical adult salmon migrations.

Résumé

On a déterminé l'état du stock de saumon atlantique de la rivière Campbellton en 2000 d'après le nombre de saumons dénombrés à une barrière portative de comptage du poisson installée dans le bras principal du cours d'eau juste en amont de la limite extrême des eaux de marée, ainsi que d'après les données biologiques recueillies au site de dénombrement et lors de la pêche sportive. Un des aspects de l'état du stock est défini par la comparaison entre la ponte réelle et la ponte nécessaire pour satisfaire les besoins de conservation. En 2000, la remonte d'adultes se chiffrait à 1798 petits et 208 gros saumons, nombres qui sont respectivement inférieurs aux moyennes de 3061 petits et 333 gros saumons pour la période 1993-1999. Les données historiques indiquent que vers 1800, environ 12 000 adultes avaient été capturés dans une bordigue mouillée dans la rivière. Les œufs pondus en 1993, en 1994 et en 1995 ont affiché un taux de survie en eau douce (jusqu'au stade de saumoneau) de 0,69 %, 0,71 % et 0,51 %, respectivement, tandis que le taux moyen de survie des saumoneaux jusqu'au stade de madeleineau était de 4,95 % pour les années 1993 à 1999. En 2000, la ponte a atteint 157 % (IC à 95 % = 125 à 175 %) des besoins au titre de la conservation. Pour la période 1993-2000, les besoins au titre de la conservation dans la rivière Campbellton ont été comblés à 267 % en moyenne. Toutefois, la remonte de 2000 dans la rivière Campbellton était de moins de 30 % des migrations de saumons adultes du passé.

Introduction

The Campbellton River (Indian Arm River) flows in a northeasterly direction emptying into the sea at Indian Arm, Notre Dame Bay. In total, Campbellton River has a drainage area of approximately 296 km^2 with an axial length of 40.22 km with a mean width of 7.4 km (Porter et al. 1974) and is about the average size for salmon rivers along the northeast coast of insular Newfoundland. The drainage area is also a protected water supply area, which provides domestic water for the town of Campbellton. The river is located in Salmon Fishing Area (SFA) 4 (Fig. 1), a very productive salmon area which, on average, accounts for about 23 percent of all salmon landed by the recreational fishery in the province of Newfoundland (Table 1). During the early to mid-1980s, Campbellton River attracted an average of just over 2,000 rod days. However in following years, angling effort declined by 50 percent, increasing again after 1992 to approximately 1,500 rod-days (Table 2). Catches in the commercial salmon fishery between 1984 and 1990 declined considerably for the island of Newfoundland and the fishery was closed in 1992. In SFA 4, the commercial catch in 1991 experienced a 64% and 47% drop for small and large salmon, respectively, when compared to the mean catches in 1984-90 (Table 3).

In this paper, we examine the status of Atlantic salmon in Campbellton River. Counts obtained from smolt and adult counting fences are used in conjunction with recreational fishery data and biological characteristic data to calculate total river returns and spawning escapements. Status of the Atlantic salmon stock is evaluated against a conservation requirement which is calculated in terms of available fluvial and lacustrine habitats.

Management Measures

In 1992, a major change was introduced in the management of Atlantic salmon. A five-year moratorium was placed on the commercial fishery in insular Newfoundland, while in Labrador fishing continued under quota until 1998 when the salmon fishery was also closed. In addition, a commercial license retirement program went into effect in both insular Newfoundland and Labrador reducing the number of licenses by 96%. Presently, approximately100 commercial salmon licenses are still held by Newfoundland and Labrador fishers. These commercial salmon fishing closures are still in effect for 2000. All of these management measures were aimed at increasing river escapements, thus contributing to the increased numbers of upstream migrating adult salmon. Also, a moratorium on the Northern Cod Fishery in NAFO Divisions 2J and 3KL was implemented in early July of 1992 and followed by NAFO Divisions 3Ps, 3Pn and 4R in 1993. These closures should have resulted in the elimination of salmon by-catch in cod fishing gear in SFAs 1-9 in 1992 followed by SFAs 10 - 14A in 1993. The commercial cod fishery moratorium continued in 1998 with exception of a limited commercial fishery in 3Ps and recreational hand-line fishery. In 1999, cod fishery re-opened in NAFO Divisions 2J and 3KL with a test fishery of 9,000 t and 3Ps had a quota of 30,000 t., however in 2000 both areas were reduced to 7,500 and 20,000 t. respectively. At present an ongoing cod test fishery (Sentinel Survey) takes place at various locations around the island. A study of the salmon by-catch in the inshore capelin fishery was undertaken by DFO in 1983 at several

major bays around Newfoundland. The results of this study indicated that very few salmon smolts were caught as a by-catch in this fishery (Reddin and Downton, unpublished report 1983). Also, since this fishery has been very late in the past several years, little over-lap has occurred with the seaward migration of smolts. Therefore, it is assumed that the by-catches of the two major fisheries around the island have had little impact on salmon populations since 1991. However, reports indicate that adult salmon are caught in herring nets used to catch bait for lobster pots. The impact of the by-catch of salmon in this fishery is unknown.

In the recreational fishery, in 1992 and 1993, a quota on the number of fish that could be retained was introduced in each Salmon Fishing Area (SFA). The quota was assigned for an entire SFA and was not administered on an individual river basis. Only hook-and-release fishing was permitted after the quota was caught. In 1994, SFA recreational fishery quotas were eliminated. In place of quotas, for insular Newfoundland, the season bag limit for retained small salmon was lowered from eight to six fish, three to be caught prior to July 31 and three after that date up to the end of the fishing season. Hook-and-release fishing was permitted throughout the fishing season. These measures remained in effect in 1997 and applied to salmon angling on Campbellton River. However, due to low salmon returns in 1997, all rivers were closed to retention as of July 28 and then on August 1st both retention and hook and release fisheries were closed which remained in effect to the end of the season. In 1998, the retention of one fish was permitted during the initial part of the fishing season until an in-season review in July was completed allowing another 3 fish to be retained, thus giving a four fish retention quota. In 1999, a River Classification System was introduced for scheduled rivers on the island portion of the province. Campbellton River was designated Class II which set four salmon as the season retention limit. The daily limit is two fish per day and catch-and-release limit of four fish per day. Also fly fishing with barbless hooks was made mandatory for all rivers. As in previous years, retention of large salmon was not permitted in insular Newfoundland.

In years 1999 and 2000, the recreational fishing season started on June 15 and ended on September 7. Also for both of these years many rivers in SFA 4 were closed to salmon, including Campbellton River due to adverse water conditions, in 1999 the closure took place on 23 July and reopened on 16 August and in 2000, rivers were closed from 9 August to 17 August.

Methods

ANGLING FISHERY

Catch and effort data for Campbellton River as well as other rivers in Newfoundland and Labrador were collected by Department of Fisheries and Oceans (DFO) Fisheries Officers until 1996. Beginning in 1997, a License Stub Return System was used to collect data directly from anglers in all SFAs of Newfoundland and Labrador with the exception of SFAs 1 and 2 in Labrador (O'Connell et al. 1998). Data for both methods were processed

by DFO Science Branch staff. Procedures for the collection and compilation of angling data are described by Ash and O'Connell (1987) and O'Connell et al. 1998.

UNRECORDED MORTALITIES

Complete understanding of all life history factors including sources of mortality is an important part of any stock assessment (Ricker 1975). Mortalities due to fishing but not recorded as part of the catch statistics have been defined as non-catch fishing mortalities (Ricker 1976). Non-catch fishing mortalities should include those fish killed due to both illegal and legal fishing activities. Legal fishing mortalities of salmon in Newfoundland and Labrador include catches in food (First Peoples), angling, sentinel and commercial fisheries. Illegal mortalities include poaching in both the freshwater and marine environments. Illegal mortalities by their very nature are extremely difficult to quantify and generally are unrecorded. An indirect method of quantifying removals by illegal means and by predators is by observation of net marks, scars and abrasions on salmon at enumeration facilities. During 1993-2000, fish with visible marks were observed at Campbellton River by closed-circuit video and visual observations. These observations provide a minimum estimate of the incidence of marked fish because of low light conditions or minor scarring that render some marks invisible. The incidence of marks does not quantify unrecorded mortalities but does provide an indication that illegal or legal by-catches of salmon and/or predation was likely occurring at sea for Campbellton River salmon prior to their entry into freshwater. However, several illegal salmon fishing charges were laid by DFO on activities that occurred at sea and in Campbellton River over the past several years.

In addition, quantification of mortalities arising from the practice of hook and release fishing for salmon are also important for accurately assessing spawning escapement. A hook and release mortality study done in 2000 on the Conne River, Newfoundland resulted in a mortality rate of 8.2 % (4 fish) for a total of 49 fish that were angled (Dempson et al. 2002). Also, studies elsewhere have shown that mortality rates of hooked and released 'bright' salmon are also relatively low. Angling mortality is dependant in part on the skill of the angler, method of fishing and length of time the fish are handled, length of residence of the salmon in freshwater prior to angling, and most important the temperature of the water. Recent studies in New Brunswick indicate that rates of 10% are possible (Brobbel et al. 1996; Dempson et al. 1998; Anon.1998b).

Another source of unrecorded mortalities is from poaching above the counting fence. Due to the illegal nature of poaching the enumeration of the number of salmon caught illegally on Campbellton River is not possible. However, these additional removals potentially result in a lower than indicated number of spawners. Thus, calculation of spawning escapement based on counts at the fence should be regarded as potential only.

SMOLT AND ADULT SALMON COUNTS

Smolt and adult counting fences were installed according to the description in Anderson and McDonald (1978). The smolt fence was in place and fishing on the main stem of the river by 28 April, 2000, just above the site of the Old Horwood Dam (same site since 1993), which is 345 m upstream from the highway bridge at the mouth of the river (Fig. 2). The entire fence was comprised of 38 sections, each 3 m in length, and a standard 2.1 x 2.1 m smolt trap installed across a 68 m section of the river. The substrate was mainly bedrock with large and small boulders and minor amounts of loose gravel. This site was chosen because it has a stable substrate and adequate water levels for fish passage during the smolt migration period. During the smolt run, the trap was checked and fish released on a regular 2-hour basis from 0600 hrs to 2230 hrs. Also, at each trap check several environmental parameters were measured, i.e. water temperature, air temperature, and water level. During the peak smolt run and when other species numbers were low, two 30 cm openings were made in the fence on each side of the smolt trap by removing the conduit. A light colored plywood board (50 cm x 75 cm), was positioned and secured along the fence on the river bottom to visually count fish passing through the fence on their downstream migration. The smolt fence was removed on 14 June 2000. As in previous years, the end of the smolt migration was enumerated via the adult fence after the smolt fence was removed. This procedure is followed when a portion of the downstream smolt migration overlaps with the upstream adult salmon run. In 1999, the smolt migration was completed before the start of the adult migrations, due to early spring conditions. However, due to the later spring for 2000, the smolt and adult runs overlapped and resulted in 2% of the total smolt run being counted via the adult fence. The smolt enumeration for 2000 is considered a complete count.

The adult fence was situated just below the Old Horwood Dam, approximately 212 m from the mouth, on a narrow bedrock shelf substrate in a 25 m wide section of the river (Fig. 2). On the immediate downstream and upstream sides of the counting fence water levels are fairly deep (2-3 m). The fence had 16 sections (3 m long) and a 2.1 x 2.1 m adult trap, and was operated from June 2 to September 26, 2000. A tunnel with a video camera system (VHS format) was installed in the trap giving a positive overhead view of salmon moving upstream. Videotapes were reviewed the next day to count salmon and the count verified by a second viewing. If necessary, a third viewing was made to resolve any discrepancies. This system has proven to be very successful since first installed in 1993 and has allowed salmon to move upstream through the fence unimpeded, especially during the night when visual monitoring becomes more difficult. Use of the camera system seemed to move salmon through the fence more quickly than would have been the case with a standard fish trap. Also, during daylight hours, a 0.5 m section of the fence next to the trap was opened into a 1 x 2 m sampling trap and monitored manually to further facilitate upstream migration and to retrieve archival tags from adult salmon run and to do biological sampling. Manual counting of salmon at the fence site from 1993 to 2000 accounted for 40-50% of the upstream migrating salmon passing through the fence. All salmon counted were sized into three categories, viz. small salmon less than 63 cm and large salmon 63 cm or greater. This was achieved by placing parallel marks 63 cm apart on the floor of the

trap/counting device. Also, any adult salmon less than 40 cm were recorded separately to separate 0+ precocious postsmolts from grilse.

SEA SURVIVAL & PREVIOUS SPAWNERS

Sea survival was determined from the number of returning adults in the current year (n+1) divided by the number of smolts in the preceding year (n). Adult salmon counted at the fence consist of several year classes including salmon spawning for the first time labelled grilse and salmon that had previously spawned. Because only the grilse originated from the smolt run of the previous year, sea survival calculated with upstream migrating previous spawners removed from small salmon counts will provide a more accurate measure of sea survival. The number of previous spawners in the returning adults was determined by mark-recapture. These previous spawners were tagged as kelts, when they left the river, with Floy T-bar anchor tags with different colors and positions on the dorsal fin for each year. Year of tagging could then be identified by tagging position on the video screen of the counter or manually as they passed through the fence. Multiple uses of the same tagging position after 4 years has shown very little overlap between tagging years from tag return fish. The percentage of downstream migrating previous spawners (kelts) tagged from 1994 to 2000, was 33.2%, 23.9%, 24.6%, 15.0%, 31.1%, 30.8% and 29.8%, respectively. Counts of small and large salmon were then adjusted for the number of previous spawners based on the ratio of tagged to untagged fish in the returning run and the number of outgoing kelts originally tagged.

POSSIBLE CAUSES OF LOW RETURN RATE IN 2000

The causes of low return rates to counting fence at Campbellton River in 2000 were examined from time series of return rates of virgin grilse and repeat spawners. Observations on predation by cod on smolts in 1998-99, activities of seals in Campbellton River estuary, and return rates of Floy T-Bar tags from baitnets were all used to infer possible causes of low return rates in 2000. Return rate for grilse (virgin 1SW salmon) was measured as the smolt count in year n divided into the count of small salmon corrected for repeat spawners in year n + 1. Return rate of repeat spawners was measured as the number of downstream migrating kelts in year n counted at the smolt fence divided by the number of returning repeat spawners at the adult fence in the same year. Reference year for grilse is year n + 1 and for repeat spawners is year n so that their respective rates can be easily compared.

ENVIRONMENTAL DATA

During field operations, environmental data were collected at both fence sites. Water temperatures were recorded by a Hugrun thermograph set at 1 m from the surface at the fence site. Cloud cover, relative water levels, weather conditions and air temperatures were also recorded. Marine temperatures were obtained with a Hugrun thermograph set just off Comfort Cove in 30 m water depth. Water temperatures have been collected at this location by DFO since 1974. Also, a thermograph was set in 1995, 1999 and 2000 at an 8 m depth near the mouth of Campbellton River, Indian Bay.

EXPLOITATION RATES

Exploitation rates for the angling fishery were derived based on the number of small salmon counted at the fence and the number of salmon reported to have been caught by the angling fishery. Estimates of fishing mortality by hook and release were included.

EXPLOITATION OF LARGE SALMON

The impact of retaining large salmon in the angling fishery on the egg deposition and percent of conservation requirements met on Campbellton River was examined based on biological characteristics of salmon sampled as kelt as they departed the river in the spring and the effect of removals of large salmon. The latter was approached in a risk analysis format whereby exploitation rates of 0%, 10%, 20% and 30% were assumed for a potential angling fishery on large salmon in Campbellton River due to the absence of any known information.

BIOLOGICAL CHARACTERISTICS

Biological characteristics were collected from salmon caught in the angling fishery on Campbellton River from 1992-2000. Samples were collected by staff at the counting fence and post-secondary students hired by HRDC through the Challenge Program, under the guidance of DFO technical staff. These students were responsible for collection of information on fork length, weight, sex, scales and ovaries. The biological characteristics, viz. percentage female, mean weights, and fecundity from the sampling program were used to estimate egg depositions in 1993 to 2000 and used to convert conservation requirements in eggs to spawning requirements in number of fish. Also, the percent of the conservation requirement egg deposition achieved was assessed.

Fecundity was determined from ovaries collected from the recreational fishery. Ovaries were stored in Gilson's fluid until transferred to 10% formalin. Eggs, which for the most part were in early stages of development, were counted directly. The relative fecundity value used to calculate egg deposition for both small and large salmon was 2,100 eggs per kg and was derived from the mean of 78 samples taken in Campbellton River, 1993-95.

CONSERVATION REQUIREMENTS

The accessible parr-rearing habitat for Campbellton River is 5,960 units (a unit being 100 m^2) of fluvial habitat and 4,037.3 ha of pond habitat (Reddin and Downton 1994). The ratio of lacustrine to fluvial habitat of 67.74 is lower than the mean of 87.11 for other SFA 4 rivers (O'Connell and Dempson 1991). However, the smolt lacustrine production levels may be much higher than 7 smolt per hectare since many of the ponds are very shallow, making them more suitable for parr rearing. Reddin and Downton (1994) estimated potential smolt production for Campbellton River of 46,141 smolts by multiplying the amount of fluvial and lacustrine habitat by production parameter values of 3 smolts per unit (100 m^2) of fluvial habitat and 7 smolts per ha of lacustrine habitat (O'Connell et al. 1991).

The conservation requirement for Campbellton River of 2,916,126 eggs was derived using egg deposition rates of 240 eggs per 100 m^2 for fluvial parr rearing habitat (Elson 1957) and 368 eggs per hectare for lacustrine habitat (O'Connell et al. 1991; Reddin and Downton 1994). Although these values may be habitat and river specific for systems from which they were derived, they are used to represent a threshold or danger zone to be avoided (O'Connell et al. 1991). Conservation requirements in eggs were converted to adult small salmon by the following formula:

(2,916,126 / (Proportion female * mean weight female * fecundity))

TOTAL RIVER RETURNS, SPAWNING ESCAPEMENT, AND EGG DEPOSITION

The egg deposition for small salmon was based on the number of spawning adult female salmon and biological information collected from the angling fishery, 1992-2000. Since large salmon cannot be retained in the angling fishery, default values for percent female and mean weight from several rivers in Notre Dame Bay were used (O'Connell et al. 1996).

Total river returns

Total river returns (TRR) were calculated as follows:

(1) $TRR = RC_b + HRM_b + C$

where,

RC_b = retained angling catch below counting fence

HRM_b = hook & release mortalities below counting fence assessed at 0.1 of the number hooked &released salmon

C = count of fish at counting fence

Spawning escapement

Spawning escapement (SE) was calculated as the difference between the number of fish released from the counting fence (FR), the recreational catch retained above the fence (RC_a) and hook and release mortalities above the fence (HRM_a).

(2) $SE = FR - RC_a - HRM_a$

Egg deposition

Egg deposition (ED) was estimated separately for small and large salmon and then summed as follows:

(3) $$ED = SE \times PF \times RF \times MW$$

SE = number of spawners
PF = proportion of females
RF = relative fecundity (No. eggs/kg)
MW = mean weight of females

O'Connell and Dempson (1997) reported that unpublished evidence exists demonstrating that atresia (non-development of eggs) occurs to varying degrees in insular Newfoundland salmon. This phenomenon has also been reported in Atlantic salmon in the Soviet Union (Melnikova 1964) and in France (Prouzet et al. 1984). Therefore, fecundity values should be regarded as potential values. Since the fecundity values used to derive conservation requirements are based on eggs in early stages of development, the occurrence of atresia in a given year on a particular river would result in a decrease in the number of eggs spawned and the conservation requirements met would be lower than reported.

ACCURACY OF EGG DEPOSITIONS

The accuracy of the estimates of annual egg deposition is very important as it describes the status of the salmon stock in Campbellton River. Because of its importance, it is worthwhile investigating the accuracy of the estimates, which was done by two different methods. First, by a simulation exercise, which investigated the effect of variability associated with the values of several parameter used in the calculations and the potential effect of this variability on egg deposition. In the calculation of egg deposition, only the number of small and large salmon returning to Campbellton River in 1993-2000 was known with certainty, and although point estimates from sampling programs were used for other values, these other values are in fact variable. In order to account for some of this uncertainty, we assumed a variation of ±10% for the values of fecundity, percentage female and mean weight of both small and large salmon. The egg depositions were recalculated 5000 times with an assumed uniform distribution. The frequency and probability distributions of the resulting egg deposition estimates were plotted to determine the mode and the 95th percentiles.

The second method of investigating accuracy of egg deposition values was by recalculating the annual egg deposition from the biological characteristics of the upstream migrating adults sampled in the angling fishery compared to that derived from downstream migrating kelts measured at the smolt fence in the following year. The same equations are used for both estimates. If the number of samples are adequate to define biological characteristics of either group then the egg depositions from the two methods should be similar. Egg depositions from kelts are based on the number of eggs per cm whereas eggs per kg are used for the upstream migrating salmon.

SALMON POST-SMOLTS

Salmon post-smolts that return to spawn after only a couple of months at sea instead of at least a full year occur in some Newfoundland rivers. Beginning in 1995, a 35 cm mark was installed in the tunnel of the video counting chamber of the adult counting fence in Campbellton River to enable enumeration of this class of salmon. This class was defined as fish between 35-40 cm. Verification of the age class of these post-smolts salmon was done by scale analysis. Data are available for 1995-2000.

EFFECT OF MORATORIUM

The effects of the commercial salmon fishing and cod fishing moratoria were examined through the time series of egg depositions and resulting smolt production, sea survival rates, and conservation requirements met. Although the effects of the commercial salmon and cod moratoria cannot be estimated separately, both continued in 2000 and would have impacted on the spawning escapement beginning in 1992. The goal of the commercial salmon fishing moratorium was to increase spawning escapement while the goal of the northern cod fishery moratorium was to protect and stimulate recovery of cod stocks to previous numbers. Because salmon are caught as a by-catch in non-salmon gear, especially cod traps, the effect of the cod moratorium would be to increase spawning escapement.

The time series of data for Campbellton River is eight years (1993-2000) which restricts analyses that compare data from before (prior to 1992) to during (post 1991) the moratorium period. However, because smolts ages from Campbellton River are mainly 3^{+} and 4^{+} (96% on average) we can examine the smolt output of several year classes of spawners from before and during the moratoria as follows:

Category	Year class (spawners)	Smolt years
Before	1989	1993 & 1994
Before	1990	1994 & 1995
Before	1991	1995 & 1996
During	1992	1996 & 1997
During	1993	1997 & 1998
During	1994	1998 & 1999
During	1995	1999 & 2000

Results

ANGLING FISHERY

In 2000, the angling salmon fishery on Campbellton River has recorded landings (retained + released) of 231 small salmon and 5 large for a total of 236 (Table 2). Of these, 48 small and 5 large salmon were hooked and released. In 1996, 31 large fish were reported as hooked and released which is the highest value since 1992. While for small salmon the highest value occurred in 1998 with 281 fish recorded. The higher annual recreational catches since 1992 when compared to several years prior to that year are attributed to increases in the salmon returns as a result of the closure of the commercial fishery and to increased angling effort. However, catches have not reached levels of the early 1980.

Since 1993, during the adult fence operations, the river was closed to angling from 43 m above the counting fence at the Old Horwood Dam site to saltwater. However, a section of the river referred to as the "V" located at the Old Horwood Dam that received most of the fishing effort on the lower section of the river in years previous to the installation of the counting fence remained open. The next site of extensive angling was centered around the lower part of Second Pond and resulted from an upgraded forestry road and new bridge which were constructed in 1992 and provided easier access to this part of the river. The main stem between Fourth Pond and Indian Arm Pond and the lower portions of Indian Arm Brook and Neyles Brook were also popular fishing sites. Also ongoing extension and new logging roads into the river has increased the accessibility which should result in an increase in angling effort.

Water temperatures and levels in 1999 and 2000 were generally good for the first part of the angling season until mid-July. However, after mid-July to mid-August very low water levels and high water temperatures occurred that restricted salmon at sea moving into the system. During this period in 1999 many salmon were noted jumping in the estuary just outside the bridge and it wasn't until a heavy rainfall on August 15 that these fish entered the river. During a 5-day period after the rainfall 14% of the total run for the season entered the river. Similar water levels and temperatures occurred in 1997 and reflected the same migration pattern. In 2000, low water levels and high temperatures occurred towards the beginning of August that resulted in a 9 day angling closure. However, 88 % of the adult run had gone past the counting fence by then.

SMOLT AND ADULT SALMON COUNTS

In 2000, the counts at both downstream and upstream fences are considered to be complete. In 2000, a total of 35,596 smolts and 1,597 kelts passed through the downstream fence (Table 4). Smelt, eels and brook trout were also counted. The peak of the smolt run occurred in standard week 21 (May 21 - 27) which accounted for 24.9% of the total migration (Table 5). Beginning in 1997, the smolt run has taken place earlier (Fig. 3). Of the eight years for which smolt counts are available, 1999 smolt run was the second lowest in number, just below the 1993-98 mean. The 1996 smolt run was the earliest to start and 1997 was the latest (Fig. 3). The difference in run timing for 1996 and 1997 may be

attributed to spring conditions, in particular higher than normal water temperature, which seemed to have a direct effect on timing of smolt migration. The smolt run doubled from 31,577 in 1993 to 62,050 in 1997 which is the highest run since the downstream migration has been monitored. A steady decrease in total smolt counts occurred from 1998 to 2000 (Table 5). The mean smolt count for 1993-2000 was 45,833. This value is just under the potential smolt production value of 46,141 derived for Campbellton River.

In 2000, a total of 1,798 small and 208 large salmon were counted as they passed upstream through the adult fence (Table 6). The first adult salmon was counted on 2nd June and the last fish was counted on 26th of September. On average, weeks 25, 26, 27 and 28 combined accounted for about 70.6% of the upstream migration, 1993-2000 (Table 7). In 1998, week 25 accounted for 51% of the total run, which is the highest percent to occur in any one standard week during the counting fence monitoring program. This may be attributed to very favorable water conditions that occurred throughout the upstream adult migration for that year. Large salmon (>63 cm) returns in 2000 represented 11.57% of the total run. Generally, the peak run for large salmon occurs after the peak for small salmon for Campbellton River as reflected for 1993-2000 upstream migrations. Most large salmon are returning as repeat spawners.

In 2000, the adult counting fence was in operation from 2 June to 26 September and the entire run was counted (Table 7). In 1996, the counting fence was removed on 20 August due to reductions in funding. Based on small salmon counts from 1993-95, the percentage of salmon entering after 20 August ranged from 0.6 to 0.8%. If the percentage after 20 August from previous years is applied to the 1996 count, then there may have been 18 to 27 small salmon entering the river after 20 August, 1996. For large salmon, the percentage entering after 20 August ranged from 1.8 to 3.7% and may have resulted in 10 to 21 large salmon entering the river after 20 August, 1996. Since these numbers represent only a small percentage (approximately 1%) of the total count, the early removal of the fence in 1996 would have had little impact on the adult salmon count. All other years were complete counts and require no adjustment.

Both smolt and adult salmon runs at Campbellton River were considerably earlier in 1996 than in either of the other eight years (Figs. 3&4). This was possibly the result of the warmer spring conditions that prevailed in 1996. Consequently, the number of adult salmon that may have entered after the 20 August may be even lower than calculated based on run timing in other years. Before the adult fence was removed on 20 August, the river downstream from the fence was checked visually via snorkeling and no salmon were observed. Therefore, it is assumed that a complete upstream count of adult salmon was achieved in 1996.

Visual checks are done each year before the removal of the adult fence. In 2000, 48 salmon were counted just below the fence and is the first time that any significant numbers of fish were observed. Of these 48 salmon counted via snorkeling, 46 appeared to be less than 40 cm. Three of these small fish were taken and sampled. Scale aging verified they were post-smolt stage salmon.

SEA SURVIVAL AND PREVIOUS SPAWNERS

Smolt-to-adult survival (uncorrected for repeat spawners) for the 1999 smolt class from Campbellton River (SFA 4) was 3.80% (Table 8, Fig. 5). This was the second lowest for the 1993 to 1999 smolt year classes. The mean uncorrected survival rate for the 7 years 1993-1999 is 5.81%. These values are overestimates of survival from smolt to 1SW (grilse) salmon because some of the small salmon migrating upstream are in fact previous spawners that survived from grilse that migrated upstream in previous years. Kelts tagged passing through the downstream smolt fence allowed for correction of the number of previous spawners in the upstream run and calculation of sea survival rates for 1SW salmon excluding previous spawners [calculations to correct these values for repeat spawners are summarized in Appendices 1 to 8]. The results of the tagging study indicated that 33.4% of the small salmon returning to Campbellton River in 1997 were previous spawners (Appendix 4). For the 1997 smolt class, the corrected survival rates after removal of previous spawners was 2.25%, which was the lowest percent during the fence operation from 1993-2000 (Table 8). Average corrected sea survival for salmon returning to Campbellton River was 4.95%, 1994-2000. The average over-wintering freshwater survival of salmon spawning in Campbellton River is 72.3% from 1994 to 1999. Due to the late installation of the counting fence in 1998, many kelts had already migrated out of the system, therefore a complete count couldn't be obtained. Thus, survival rates had to be derived from average of rates of previous years. The mean percentage for both large and small salmon combined that consist of previous spawners for the upstream run from 1994 to1999 is 23.3%. This number may be slightly higher due to tagged kelts that were either taken at sea or migrated to other river systems. Returns from 3,372 tagged kelts from 1994 to 2000 indicated that 1.69% kelts strayed to other rivers mainly in Notre Dame Bay and 2.03% were caught at sea. One salmon, tagged at Campbellton River on 9 May, 1999 at 47 cm in length was gill netted at Kangamiut, West Greenland at 60 cm in length on 15 September, 1999. However in 2000, previous spawners only made up 7.24% of the upstream small adult run which is the lowest return rate since the start of the monitoring period in 1993 (Appendix 7).

Analyses of the data from previous years indicated that kelts returned to Campbellton River after an average of 65 days at sea and put on between 4-6 cm in length. The return rates for previous spawners from 1994 to 2000 were 25.58%, 34.83%, 39.38%, 39.00%, 38.56%, 41.07%, and 9.09% respectively (Appendices 1 to 7).

ENVIRONMENTAL DATA AND WATER QUALITY

Water temperatures in Campbellton River for 2000 ranged from a low of 5°C on 1 May to a high of about 25.5°C on 17 July (Fig. 6). In 2000, both water temperatures and water levels stayed within a desirable range (less than 22°C) for salmon during May to mid-July; however after mid-July to the end of August, conditions were less favorable to upstream migrations (Fig. 6). Mean water temperatures for 2000 were higher than the 1993-98 mean temperatures. Unfavorable freshwater conditions (low water levels and high water temperatures) which are becoming more and more common during summer months in Newfoundland can act as a barrier to salmon migration. During these periods, some

salmon will remain in the estuary only ascending the river after sufficient rainfall has ameliorated freshwater conditions. This occurred at Campbellton River in 1997 and 1999.

Maximum and minimum air temperatures for 2000 were 33.5 and -4.5 °C between 18 April to 27 September (Fig.7). Estuary temperatures for 2000 taken from a thermograph located near the mouth of the river at a depth of 8 meters ranged from –0.3 to 19.9 between 7 May to 22 September (Fig. 8).

Water samples were collected in 1987, 1990, 1992 and 1994 by Water Resources Management Division (Government of Newfoundland and Labrador), and in 1973 and 2000 by DFO. All samples were taken near the mouth of the river. Water analysis were done by Water Analysis Laboratories (Mount Pearl, Newfoundland) except for 1973 that were by DFO. Results are presented in Table 9. Overall water quality for this river appear to be similar with water quality of other rivers on the northeast coast of Newfoundland.

EXPLOITATION RATES

In 2000, a total of 1,798 small salmon passed through the counting fence and there was a catch of 183 small salmon retained by the angling fishery above the fence. Although the river was closed to angling below the fence to salt water, fish were observed to be taken illegally. This is consistent with previous years; however, it is assumed that the number removed illegally represented only a very small proportion of the total run. The exploitation rate above the fence in 2000 was 10.2% for small retained salmon (95% CI= 9.05-12.90%). Exploitation on small salmon (retained only) peaked in 1996 at 14.4% then declining to 6.1% in 1999. In 1999, low water conditions resulted in the river being closed which reduced exploitation. In 1998, the exploitation rate for small released salmon was highest at 20%. Exploitation on the total population increased by about 50% from 1993 to 1996 and then declined. Although the river was closed for a short period in 2000, it had little impact on recreational angling exploitation rate since 87% of the fish had gone through the fence and the closure was only for 8 days. Exploitation rates are shown in the following text table:

Year	Small retained	Small Ret. + rel.	Large released	Total
1993	7.9%	10.5%	0.0%	10.1%
1994	11.9%	12.0%	0.5%	11.3%
1995	12.9%	14.5%	0.5%	13.6%
1996	14.4%	17.3%	5.5%	15.6%
1997	12.9%	16.3%	2.8%	14.4%
1998	11.5%	20.0%	2.0%	18.9%
1999	6.1%	8.4%	2.4%	7.6%
2000	10.2%	12.8%	0.3%	13.1%

EXPLOITATION OF LARGE SALMON

The number of large salmon enumerated at the counting fence ranged from a high of 560 in 1996 to a low of 145 in 1993. All of these large salmon would be available for harvest under a retention fishery. The biological characteristic data indicate that almost all of the large salmon at Campbellton River are consecutive repeat spawners and only a few are virgin 2SW salmon or alternate repeat spawners. Thus, the genetic material transferred to future generations is presumably no different than what is present in the grilse; albeit from a different spawning class which may be important (Saunders & Schom 1985). There is no genetic information from Campbellton River salmon to further examine genetic implications.

The effect of angling on the number of large salmon spawners would depend on the exploitation rate which depends in part on run timing, fishing seasons, and fishing effort. As such, the rate of exploitation is unknown. If all of the large salmon in the runs from 1993 to 2000 had been caught and retained then on average the percent of the conservation requirement achieved would decline by 16% (annual range is 8% to 29%) but in all years conservation requirements would still be met. In Labrador, where retention of large salmon is allowed, exploitation rates range from 0% in some years to 13% in others and variability from river to river is high. Also, exploitation on large salmon in Labrador due to run timing is almost always lower than on small salmon (Lowe & Mullins 1996, Mullins & Caines 1998; Reddin et al. 1996; Reddin et al. 2000; Reddin & Short 2000). Whether similar rates would be experienced for an island fishery is unknown. Risk analysis using parameters described in the ACCURACY OF EGG DEPOSITION ESTIMATES section of this paper was parameterized using exploitation of 0%, 10% (ranging from 5% to 15%), 20% (ranging from 15% to 25%) and 30% (ranging from 25% to 35%) with a uniform distribution to evaluate the loss of some large salmon on conservation requirements. This analysis used 1999 angling catches for year 2000. At all levels of added exploitation on large salmon, the conservation requirement would still be met in year 2000 even at low levels of risk (Fig. 9). At the median, the percent of conservation requirements met at 0% large salmon exploitation was 172%, at 10% large salmon exploitation was 168%, 20% was 164%, and at 30% was 161%. The effect on conservation requirements from a large salmon fishery on Campbellton River would appear to be minimal.

BIOLOGICAL CHARACTERISTICS

Smolts: The river ages of smolts sampled at the counting fence in 1993-99 ranged from 2 to 6 years with the 3 and 4 river years representing the predominant classes and accounting for 95.9% of the samples (Table 10). From 1993 to 1997, river age 3 smolts represented the highest percentage and then there was a switch to river age 4 smolts in 1998 and 1999. The percentage of river age 3 smolts increased from 1993 to 1995 and then declined during the 1996-98 period. In 1998 and 1999, river age 4 smolts became the dominant class increasing to slightly over 50% of the run.

Approximately 0.5% of the smolt migration was sampled each year during 1993-2000, which represents an overall total of 1,887 fish. The smolt mean whole weight in 2000 of

52.3 g was slightly higher for male smolt than the 50.4 g for females; whereas, the males were 2.7 mm longer in length (Table 11). The overall 1993-2000 mean fork length and whole weight for both sexes was 173.3 mm and 48.9 g with a mean river age of 3.50 years and ranged from 2-6 years. Smolts sampled in 1993 produced the highest mean fork length and whole weight at 186.3 mm and 60.5 g.

Adult salmon: From 1992 to 2000, 302 adult salmon were sampled from the recreational fishery. The overall mean fork length of grilse was 53.14 cm with a mean whole weight of 1.58 kg and river age of 3.32 years (Table 12). Twenty-five (10%) of the small salmon that were sampled during 1992-2000 had previously spawned. Also, four fish were sampled that returned to freshwater in the same summer that they went to sea as smolts. River age of salmon sampled in the angling fishery and at the counting fence show a very high percentage of river age 3 salmon and a much lower percentage of river age 4 than the smolt sampling (Table 13). The reasons for these differences are unclear but may be related to differential survival and some years with low sample sizes from the angling fishery. A 2nd order polynomial was used to relate fork length and whole weight for adult salmon caught in the recreational fishery and gave an R^2 of 0.81 (Fig. 10). The regression of fork length and whole weight of smolts sampled at the counting fence produced an R^2 of 0.92 (Fig. 11).

The biological characteristics of salmon sampled in the recreational fishery and at the counting fence are used to annually determine the number of eggs deposited in the system by female spawners and the percent of the conservation requirement met. Since, the sampling numbers of salmon from the recreational fishery was so low in 2000 at 8 fish, sex ratios couldn't be determined. Because of low sample sizes in 1996, 1997, 1998, and 2000, the average percent female and whole weight, from 1993-2000 were used to calculate the percent of the conservation requirement met for those years (Table 14). There were no samples for large salmon available from Campbellton River due to the mandatory release of large salmon in the recreational fishery introduced in 1984, except for samples taken at the adult trap. Default values for mean weight and the percentage of large salmon that are female are 3.13 kg and 76.9%. These default values were derived from several rivers in SFA 4 (O'Connell et al. 1996).

CONSERVATION REQUIREMENTS AND POTENTIAL SMOLT PRODUCTION

The estimated conservation requirements for Campbellton River in terms of eggs as well as adult salmon were estimated as follows:

	Lacustrine	Fluvial	Total
Accessible habitat	4037.3 ha	5,960 units	-
Eggs (No. x 10^6)	1.486	1.430	2,916,126

Conservation requirements converted to numbers of small salmon (Reddin and Downton 1994):

$$= \frac{2{,}916{,}126 \text{ eggs}}{(\%\text{ female} * \text{mean wt female} * \text{fecundity})}$$

$$= \frac{2{,}916{,}126}{(0.739 * 1.55 * 2100)}$$

= **~ 1480 small salmon**

The estimated potential smolt production is as follows:

Fluvial smolt	= 3 smolts/unit * 5960 units	= 17,880
Lacustrine smolt	= 7 smolts/ha * 4,037.3 ha	= 28,261

Total potential smolt production = 46,141

TOTAL RIVER RETURNS, SPAWNING ESCAPEMENT, AND EGG DEPOSITION

Total river returns

In 2000, there were 1,798 small and 208 large salmon returning to Campbellton River (Table 15).

Spawning escapement

In 2000, there were 1,402 small and 207 large salmon potentially spawning in Campbellton River (Table 15).

Egg deposition

In 2000, egg deposition on Campbellton River was $4.590 * 10^6$ the lowest since 1993. Thus, 157% of conservation requirements in eggs were achieved in 2000, decrease of 44.5% from the potential egg deposition obtained over the previous seven years mean (1993-99). Table 15 summarises updated information on egg deposition at Campbellton River for all years in which fish counting fences have been operated.

Freshwater survival from egg to smolt is available for the 1993-95 year classes. Freshwater survival was estimated by proportioning the annual egg depositions into their appropriate year classes based on the ages from the smolt samples. For example, the 1993 year class are 2 year old smolts in 1996, 3 year olds in 1997, 4 year olds in 1998, 5 year olds in 1999, and 6 year olds in 2000. The egg depositions were $9.077 *10^6$, $6.961 *10^6$ and $8.089 *10^6$, respectively for 1993, 1994, and 1995 year classes. The smolt count for river age 5s and 6s in 2000 used the mean composition of smolts from 1993-2000 and will of course be updated. The estimated survival rates from egg to smolt were 0.69%, 0.71% and 0.51%, respectively.

ACCURACY OF EGG DEPOSITION ESTIMATES

The total egg deposition estimated for Campbellton River salmon is based on point estimates of the parameter values for the numbers of salmon spawning, fecundity, percent female and mean weight. Only the numbers of small and large salmon returning to Campbellton River in 2000 were known with certainty while the values for other parameters had a degree of uncertainty or variability associated with them because they are based on means from sampling programs. The results of recalculations of egg depositions using a ±10% variability around mean parameter values indicated that a wide range of egg depositions were possible for Campbellton River. However, the river would have attained its conservation egg requirements at all of these possible egg deposition levels in 2000 (Figs. 12 & 13). At the 50th percentile, 4,335,666 eggs were deposited which represents 149% of conservation requirement of 2,916,126 eggs based on this level of variation. The corresponding 5th and 95th percentiles of the percentage of conservation requirement met varied from 125 to 175%.

The precision of annual egg deposition values was examined by deriving egg depositions from the biological characteristics of the upstream migrating adults sampled in the angling fishery compared to that derived from downstream migrating kelts measured at the smolt fence in the following year. Comparison of values derived on fresh run versus kelts shows 311% versus 304% in 1993, 239% versus 220% in 1994, 277% versus 257% in 1995, 329% versus 285% in 1996, 187% versus 172% in 1997, 311% versus 280% in 1998 and 326% versus 268% in 1999(Table 16 a & b). The two methods were highly correlated (r = 0.95) although the egg deposition derived from kelts were lower on average by 9.5%. Because, the percentage of conservation requirements achieved is always slightly higher when based on fresh run salmon there may be a tendency to overestimate rather than underestimate the percent of conservation requirements achieved. However, the similarity of the two values suggests that the tendency to overestimate is small.

SALMON POSTSMOLTS RETURNING TO FRESHWATER

Atlantic salmon exhibit various life history patterns including several alternate habitat strategies. The entire life cycle can take place in freshwater; they can start life in the river, then migrate between river and estuary; they can migrate between river and estuary and then go to sea; or they can have the more typical anadromous life cycle of going to sea for one or more years before returning to freshwater (Power et al. 1987). In Newfoundland and Labrador, salmon migrate to sea at two to seven years of age then return to freshwater after spending at least one or more years in the sea. Salmon that have spawned one or more times after one or more years in the sea are also quite common. As evidenced by scale reading of a few salmon sampled that were caught by anglers or at enumeration facilities, a small number of salmon exist in Campbellton River that spend only a couple of months at sea before returning to freshwater. Because they do not spend a full year at sea, these salmon are typically smaller than a grilse being less than 40 cm fork length. Also, as they are uncommon in occurrence, the salmon nomenclature does not have a separate name

for this life stage and they would be labelled as postsmolts (Allan and Ritter 1977). However, in the context of this report, they are referred to as precocious postsmolts (PPS).

In 1995, anglers observed for a number of rivers, e.g. Southwest Brook in Bay St. George, a high number of very small salmon migrating upstream. In 1993 and 1994, a few very small (<40 cm) salmon were observed at the counting fence ascending Campbellton River. In the spring of 1994, several of these small salmon were sampled as kelts descending through the smolt counting fence. In total, out of 907 kelts sampled there were four or 0.4% that had not completed a full year in the sea. Another 12 or 1.4% of the kelts had no complete sea year but showed two or more spawning marks. Overall, the proportion of the run that could be labelled as precocious postsmolts is relatively minor in most years.

In 1995, precocious postsmolts between 28-40 cm in length were observed ascending through the Campbellton River counting fence. The total upstream run was 13 precocious postsmolts, out of 3,253 small and large salmon; thus, the upstream run consisted of 0.4% precocious postsmolts. In 1998, the number of small salmon less than 40 cm was 51 fish and represented 1.6% of the small salmon at the counting fence. Four of these small fish were sampled at the adult fence and all had an incomplete sea year before returning to the river to spawn (precocious postsmolts). In 1999, 83 precocious postsmolts were counted through the counting fence and represents 2.33% of the total run of the 3,569 small and large salmon. In 2000, of the 2,006 upstream run 208 or 10.4% were precocious postsmolts with 46 or 2.2% counted on the last day before the fence was removed. Generally, these fish are observed in the latter part of the upstream migration of adult salmon. Four precocious postsmolts were taken and sampled in September of 2000. The mean fork length and whole weight were 354 mm and 578 g respectively. Gonads from two females and two males were immature. However, a sample taken of a female precocious postsmolt from the smolt trap in May had retained eggs in the body cavity indicating that it had spawned sometime between the fall of 1999 and spring of 2000. The river age of three fish were 4 years and one was 5, this is consistent with ageing of precocious postsmolts from previous years in that these fish tend to have a higher river age than the 1 sea-winter salmon. In 1997 a precocious postsmolts kelt had spawned 7 consecutive. Of 5,240 Kelts sampled or tagged from 1993 to 2000, 41 were precocious postsmolts and produced a mean age of 4.2 years, of which 13 were 5 years or greater. The number of these precocious postsmolts are under estimated since only kelt of suitable size and condition were generally selected for tagging.

In 2000, five PPS were sampled, 1 from the smolt fence that represented a PPS in the kelt stage and 4 from the adult fence that just entered from the sea. The 4 PPS smolts sampled at the adult fence were all immature and the gonads represented only early stages of development. However, the PPS sampled in the spring had retained eggs in the body cavity indicating it had spawned. Also, these upstream migrating salmon are smaller in length and weight (mean 354 mm and 630 g n=4) when compared to the normal run of grilse entering Campbellton River. Therefore, the potential egg deposition model value will decrease when these fish are either removed or the biological characteristics are used for these fish. The overall impact of the 208 PPS smolts removed from the 2000 upstream count could reduce egg deposition by 10.3% or 525,888 eggs. With a three year (93-95)

mean egg to smolt survival of 0.637% could result in a total smolt reduction of 2,132 for the 2004 and 2005 migration combined, based on the modal 3+ and 4+ smolt ages. Using the overall mean smolt to adult corrected survival rate of 4.95 % from 1993 to 1999, the grilse adult run into Campbellton River could be reduced by 106 fish over the combined years of 2004-5.

EFFECTS OF MORATORIA

The smolt counts and the age information from the smolts as shown in Table 10 were organized as follows for the 3 and 4 river year classes:

Category	Year class (spawners)	Number of smolts		
Before	1989	15,631 & 12,620	=	28,251
Before	1990	25,931 & 13,805	=	39,736
Before	1991	24,774 & 20,050	=	44,824
During	1992	34,975 & 24,547	=	59,522
During	1993	35,685 & 25,009	=	60,694
During	1994	22,658 & 24,559	=	47,217
During	1995	21,766 & 17,883	=	39,649

The pre-moratoria year classes of 1989-91 produced on average 37,604 smolts; while moratoria year classes of 1992-95 produced on average 51,771 smolts. The difference between pre- and moratoria smolt production is 14,167 for an increase of 37.7%. This 37.7% percent increase in smolt production may have come about due to an increase in spawning escapement due to the moratoria or were possibly due to productivity increases in freshwater from better survival. For Campbellton River, the spawning escapement prior to 1993 is unknown. It should be noted that 3^{+} smolts in 1997-98 which also come from moratoria-year spawning escapements have declined to 22,658 and 21,766 which is similar to smolt production of 3^{+} from before the moratoria. Adult returns of small salmon from the 1993-95 smolt classes ranged from 2,857 to 3,208 with an average of 3,033 while adult returns from 1996-99 smolt classes were 1,975, and 3,275 and an average of 2,884. Thus, returns have actually declined by 149 fish or 4.9% for smolt classes from pre-moratoria and moratoria. This decline in adult returns occurred in spite of increased smolt production and seems to be directly related to sea survival which has gone from an average of 6.8% for the 1993-95 smolt classes to 4.0% for the 1996-99 smolt classes. The percent of conservation requirements met for Campbellton River from 1993 to 2000 ranged from 175% to 333% assuming that all fish, minus mortality from angling spawned (Table 15). Thus, the high number of adult returns is being maintained by the high smolt production levels. Therefore, benefits from the moratoria on commercial fishing have not yet followed through to adult returns; although higher smolt production have helped maintain adult returns in the face of lower sea survival. For Campbellton River, the smolt production in terms of smolts per 100 m^2 has been, 10.2 in 1993, 7.92 in 1994, and 6.65 in 1995. If smolt

production from river habitat is fixed at 3 smolts per unit then the pond habitat is producing 10.6 in 1993, 7.75 in 1994 and 5.39 in 1995 smolts per hectare with an average of 7.75. The average value of about 8 smolts per ha compares well with the value of 7 in O'Connell et al. (1991).

UNRECORDED MORTALITIES

At the Campbellton River fence, visible scars or marks on salmon were recorded on a daily basis. Overall in 2000, there were 11.37 % or 228 of the 2,006 upstream migrating Atlantic salmon with visible body scarring. This percent scarring is almost double the mean of 5.61 % from 1994 to 2000. These marks were observed mainly on the head of the fish, which generally is consistent with that expected from small mesh nets, i.e. used to catch herring. Because the Campbellton counting fence is only 0.25 km from the sea, these marks had to have occurred sometime before the salmon entered freshwater. Scarring and net marks were recorded from 1994 to 2000 on adult salmon migrating past the adult fence (Table 17 and Fig. 14). The mean percent scarring during the 7 years was 5.61% with the highest occurring in 2000, at 11.37%. Also, during the eight-year period of sampling angled salmon, several fish had very distinct scarring that might be attributed to predation by seals. It is concluded that there is some mortality at sea due to predation as well as natural and illegal fishing, although the overall magnitude is unknown and very difficult to quantify. A cautionary note on these results is that scars cannot be accurately attributed to predation separately from nets or net types. Therefore, while an increase in scarring rate means that there was a change in predation or encounters with nets at sea it does not necessarily mean increased mortality from predation or legal/illegal netting activities. However, the observations are consistent with an increase in one or all of these activities although we cannot separate the cause.

POSSIBLE CAUSES OF LOW RETURN RATE IN 2000

The return rate pattern for grilse has been declining since 1994-96 (Fig. 15). Substantial declines from an average of slightly over 6% to below 4% occurred in 1997 and again in 2000. Randomization tests indicated that the 1,728 grilse that returned to Campbellton River in 2000 was not significantly different from expectations given previous return rates and the number of smolts counted in 1999 (95% confidence interval from bootstrap technique was 1,063 to 3,600). Return rates for repeat spawners (kelt) actually increased slightly from 1994 to 1999 and was maintained at a high level in 1997 when the grilse return rate was low. However, repeat spawner returns declined substantially in 2000 to 145 (95% confidence interval from bootstrap technique was 409 to 656) concurrent with low smolt returns which was a different pattern from 1997. The patterns of returns of grilse, repeat spawners, and their differences suggest that the events causing these declines in 1997 were dissimilar in origin to those of 2000.

Adult salmon are a fairly large fast swimming fish with few natural predators at the adult stage; the only known predators being relatively large mammals including man (Hislop & Shelton 1993). This would suggest that predation by a relatively large predator when both repeat spawners and grilse were returning to Campbellton River and were in the same

location at the same time may have been the cause. The only time and place that these two groups were together at sea would be in late May to early July in Notre Dame Bay and outer estuary of Campbellton River. Marine mammals such as seals and bottle-nosed dolphins and man are known to prey on adult salmon (Hislop & Shelton 1993). Smolt stage predation by fish and avian predators was measured in Campbellton estuary in 1998 and 1999 and although an indirect measure of predation as the total number of predators is unknown predation incidences declined for avian predators and gadoids between 1998 and 1999. These measures while indirect would suggest that predation by mammals and/or marine removals by man at the adult stage was the cause of low returns of repeat spawners and grilse to Campbellton River in 2000.

Data available to further examine the events related to low return rates in 2000 compared to other years are records of salmon with scars at the counting fence, Floy tagging data and observations on seal predation by public and DFO personnel. The salmon scarring record from the counting fence video camera indicate the percent of scarred salmon in adult salmon moving through the counting fence at Campbellton. Between 1994-99, about 5% of the salmon were scarred but in 2000 about 11% of returning salmon were scarred. Although specifically unknown, scars are the result of jigging activities prior to the counting fence, net scars from baitnets or nets set by poachers, and predation by marine mammals. The doubling of the scarring rate indicates increased activities by some or all of the above sources in 2000.

The results of Floy tagging which has been used at Campbellton to separate returning repeat spawners from grilse also indicates catches from other sources when the tags are returned. Of course, non-reporting of tags is commonplace especially in illegal fisheries and was not measured during Campbellton studies as the objective was to determine the number of repeat spawners in the run. Overall 31% of the 4,046 kelt tagged at the smolt fence returned to the adult fence on Campbellton (Table 18). Other sources were the sentinel cod fishery, baitnets, seals, food fishery at Greenland, angling in marine areas, and observed tagged salmon in other rivers or found on beaches. The total number of tags unaccounted for was 68%. Because no information is available to correct for non-reporting, it is difficult to use this data in terms of absolute numbers. Of the tags recovered from Campbellton River, fully 50% of them were reported from baitnets; however, for every thousand salmon returning to Campbellton River there would be 14 caught in baitnets which is not very high. Adjustment for non-reporting which may be considerable would increase the number but non-reporting would have to be extremely high to fully account for the missing fish. Because of non-reporting which can be assumed to be relatively constant over time, the Floy tag data may have its best utility in terms of relative rates. The results indicate no substantial increase in tags recovered from salmon caught in baitnets in either 1997 or 2000 when return rates were lowest suggesting that while baitnets may be a contributing factor; overall, are not the cause of increased low adult returns in either 1997 or 2000.

The potential of seals as a predator of Campbellton salmon and contributor to the low return rate is shown by the observation and return from a fisherman of a Floy tag found attached to a salmon in the mouth of a seal killed in Campbellton estuary (Table 18).

During the years that the counting fence has been operated, fishermen have sometimes come to the fence site to report observations on seals and other events influencing Campbellton River salmon in the estuary and nearby Notre Dame Bay. Reports of seals in inshore areas near to Campbellton has been occurring with greater frequency in later years and was highest in 2000. In 2000, there were eight fishermen who reported seeing seals nearby Campbellton River estuary on different occasions and sometimes seals were observed chasing after salmon. Fishermen thought from their observations that it was herring that attracted the seals into the Campbellton area in the first place as there is a nearby spawning area. One fishermen, who has fished for 45 years nearby to Campbellton, maintained that 2000 was the 'worst year' for seals yet with more and more seals being sited inshore. While indirect, the available evidence suggests that seals may have been responsible for the decline in returns of salmon and especially kelt to Campbellton River in 2000.

Discussion

Taylor (1985) discussed the historical catch record for many rivers in Newfoundland and Labrador. He states that the relatively high Atlantic salmon abundance in the Campbellton River made it valuable to the Beothucks and Europeans alike. The earliest catch record specific to Campbellton River indicates that a John Ginn landed 90 tierces of salmon on or about the year 1816. Because the early European settlers fished by placing a weir across the entire river and because there was no coastal gillnet fishery, these catches are an approximation of total salmon production of Campbellton River when it was in a pristine state. The 90 tierces converts to 18,400 kg using the conversion factors of Taylor (1985). This weight of fish converts to about 12,000 salmon if the mean weights of 1993-96 period are used. The highest count in the 1993-99 period is 4,146 or about 30% of that which Campbellton River may have produced when it was in a more natural state prior to heavy exploitation in commercial marine fisheries.

At the conservation requirement of 1,480 spawners, it is expected that about 48,000 smolts would be produced by Campbellton River. At an average sea survival rate and proportion large salmon, 48,000 smolts could produce about 4,600 adult salmon. If Campbellton River still has similar freshwater habitat to that present in 1816 then perhaps the difference between the 4,600 adult salmon produced at conservation requirements and the 12,000 it produced in a more virgin state is it's maximum production. Since the percent of the conservation requirement achieved on average for Campbellton, 1993-2000 is about 267%, it would be interesting and potentially very informative to monitor adult returns in future years so that a stock recruit relationship could be developed specifically for Campbellton River.

For Campbellton River, there was no detailed habitat survey available (Porter et al. 1974). Thus, the habitat values given in this paper should be regarded as preliminary and will be subject to further review. The Campbellton River watershed has had extensive logging activity in the past, especially in the early 1900's when a 400 m long, 10 m high dam was erected by the Horwood Lumber Company near the mouth of the river to divert water into a

350 m rock-cut channel to run a pulp mill and hydro plant. At this time, the Horwood Lumber Co. had timber rights to 596 km^2 and used the river as a means to float logs to the mill. However, this operation was short lived since the dam broke in 1916 and the company went into bankruptcy. Extensive logging continued in and around the Campbellton River watershed up to 1966 when 22 small dams were removed by Price (Nfld) Ltd. under the supervision of the Department of Fisheries and Oceans. The structures from these historical logging activities are still visible in the remains of dams and tree trunks scattered at various points along the river. The remains of several dams located on the Crooked Brook tributary, which empties into Second Pond, still pose a partial obstruction to migrating salmon during low water levels. In 1961, the upper watershed near Shirley Lake and Silt Lake was completely destroyed by fire, which only now has returned to normal forest growth. Although the river is no longer used to drive logs to the sea, logging still continues over the network of roads built specifically for that purpose. The overall effects of these logging activities on the production of salmon in the system are unknown.

Since the habitat in Campbellton River has not been completely surveyed the conservation requirement may be an over- or under-estimate. The total number of adult salmon spawning in 2000 resulted in an egg deposition that was 157% of the conservation requirements. It was noted during the helicopter survey that many of the spawning areas on the main stem were located between relatively small and shallow ponds. These shallow ponds may provide for an optimal utilization of rearing habitat and a higher rearing capacity may result. Therefore, caution must be used when referring to conservation requirements until a full habitat survey is completed.

For Campbellton River, the highest smolt production of 62,050 in 1997 is 134% above the calculated potential smolt production of 46,141. The modal smolt age for Campbellton River salmon in 2000 is 4 years and thus, the smolt run for that year is derived mainly from adults that spawned in the fall of 1995. Prior to 1999 the modal smolt age was 3 years. For most Newfoundland rivers, spawning escapements were the lowest on record in the period 1989-91 (Dempson and O'Connell 1993). Escapements on northeast coast Newfoundland rivers increased in 1992 with the beginning of the commercial salmon fishing moratorium. Consequently, smolt production stemming from spawning escapements in the post-moratorium years may be much closer to this potential figure. Salmon returns to Campbellton River in 2000 is the lowest since 1993, the survival rate of smolt to adult is considered low at 3.66% when compared to rates prior to 1997.

Assumptions associated with the parameter values used to calculate the conservation spawning requirement have been discussed previously by O'Connell et al. (1991), O'Connell and Dempson (1991), O'Connell and Ash (1994) and will not be dealt with in detail here. The comments in O'Connell and Ash (1994) on further substantiation of parameter values for calculations related to egg deposition apply as well to Campbellton River. Also, it should be kept in mind that inaccuracies in catch statistics, losses to due poaching, losses due to hook-and-release mortality, and losses from natural mortality will potentially reduce spawning escapement.

Large salmon entering Campbellton River are mainly consecutive repeat spawning grilse with a very low proportion of alternate and virgin 2SW salmon. The effect of retention of these large salmon from a conservation perspective are minimal provided the run remains at its current high levels. The genetic potential and loss cannot be evaluated without specific information. However, Saunders and Schom (1985) have noted that having several generations of salmon spawning in one year has a number of life history advantages. So as long as exploitation rates on large salmon from any future fishery are low any life history effects on the population should also be low although unknown. There is not fecundity information for Campbellton River large salmon or large salmon in many Newfoundland rivers (O'Connell et al. 1997). Randall (1989) examined the effect of sea age on fecundity and reproductive potential and observed that eggs per kg were generally lower in repeat spawners than virgin grilse and 2SW salmon; although the number of eggs per fish may still be higher in the large repeat spawners than in the smaller grilse. However, because conservation requirements have always been met on Campbellton River the impact of retention of large salmon would still be minimal.

The pattern of returns of repeat spawners and grilse to Campbellton River indicate that both were low in 2000 and exceptionally so for repeat spawners. While the cause(s) will never be completely known for certain, it appears that predation by seals was the most likely source of the dramatic decrease in returns in 2000. Seals were observed feeding on salmon in Campbellton estuary and taken with the increase rate of scarred salmon appearing at the counting fence and lack of increase in the activities of man suggests the seals were responsible for the decreased returns. Dempson et al. (1998) and Anon. (1998a) exhaustively reviewed all information related to the subject and concluded that while direct evidence as to the source was lacking, predation was the most likely cause. Cairns and Reddin (2000) reviewed the evidence for predation as the source of low returns in general to Canadian rivers and concluded that seals preyed on salmon. However, to obtain data on seal population and overall interaction with salmon would be difficult. Low returns are now endemic for salmon rivers over much of their distribution in North America so much so that salmon in several rivers in Maine, USA and inner Bay of Fundy, Canada which are thought to be threatened with extinction. Also, present legislation enacted in United States has placed the wild Atlantic salmon on the Endangered Species List. Dempson et al. (1998) point out that sources of mortality may differ between rivers and between years and because of this variability we may never know for certain the cause. However, well-planned experiments and continuation of long term data series on salmon returns may prove helpful in eliminating some potential causes. We conclude although not conclusive that the most likely source of the increase in low returns of salmon to Campbellton River in 2000 was predation on adult stage salmon by seals.

In conclusion, due to the maintenance of strong adult returns in 1993 to 2000, the percent of conservation requirements being met on Campbellton River remains high in spite of lower than average sea survival in the last several years. Benefits of increased spawners released from commercial fisheries due to commercial fisheries moratoria, have not been fully realized, although increased smolt production has maintained strong adult returns.

Acknowledgments

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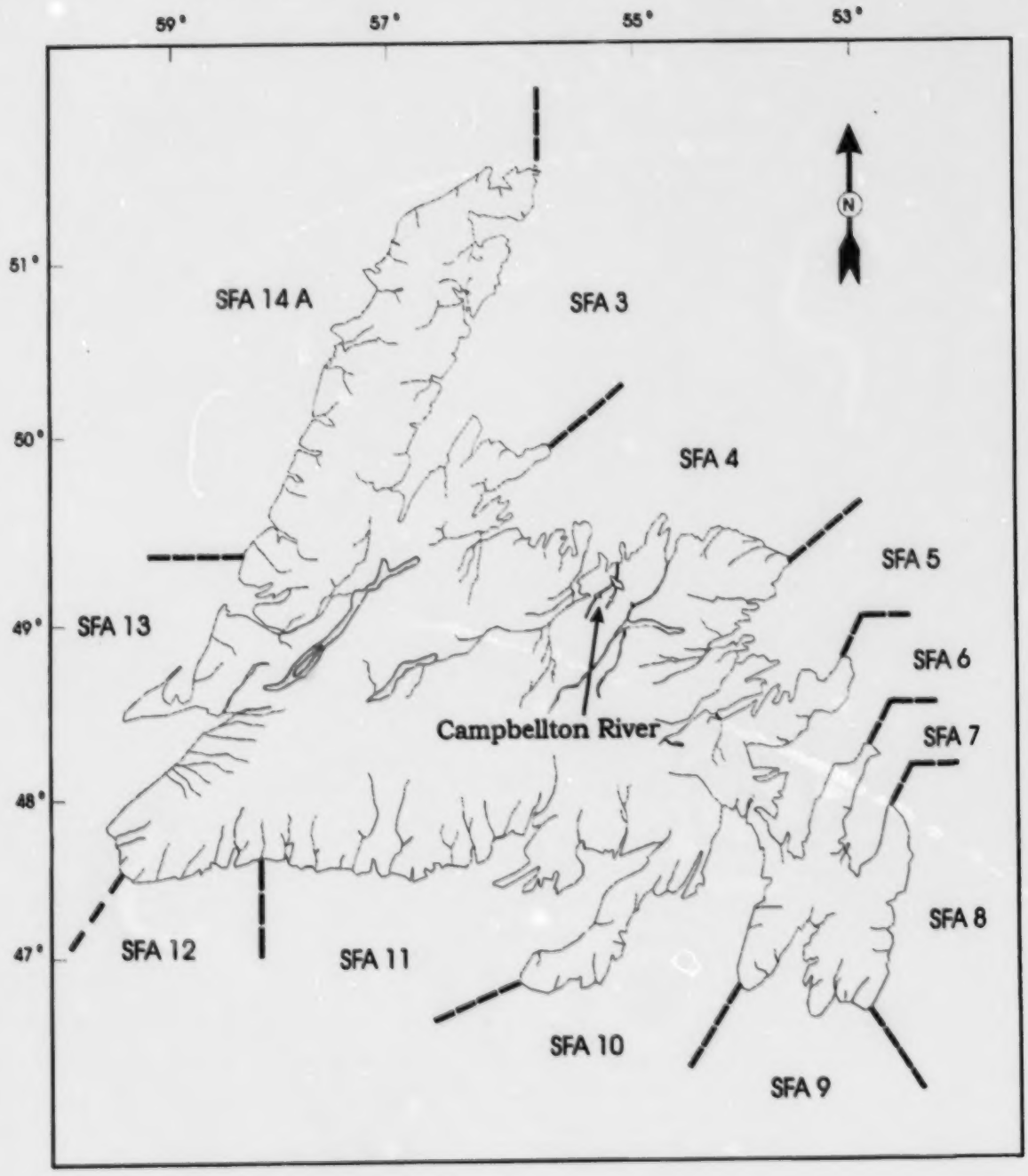


Figure 1. Salmon Fishing Areas on the Island of Newfoundland with reference to Campbellton River.

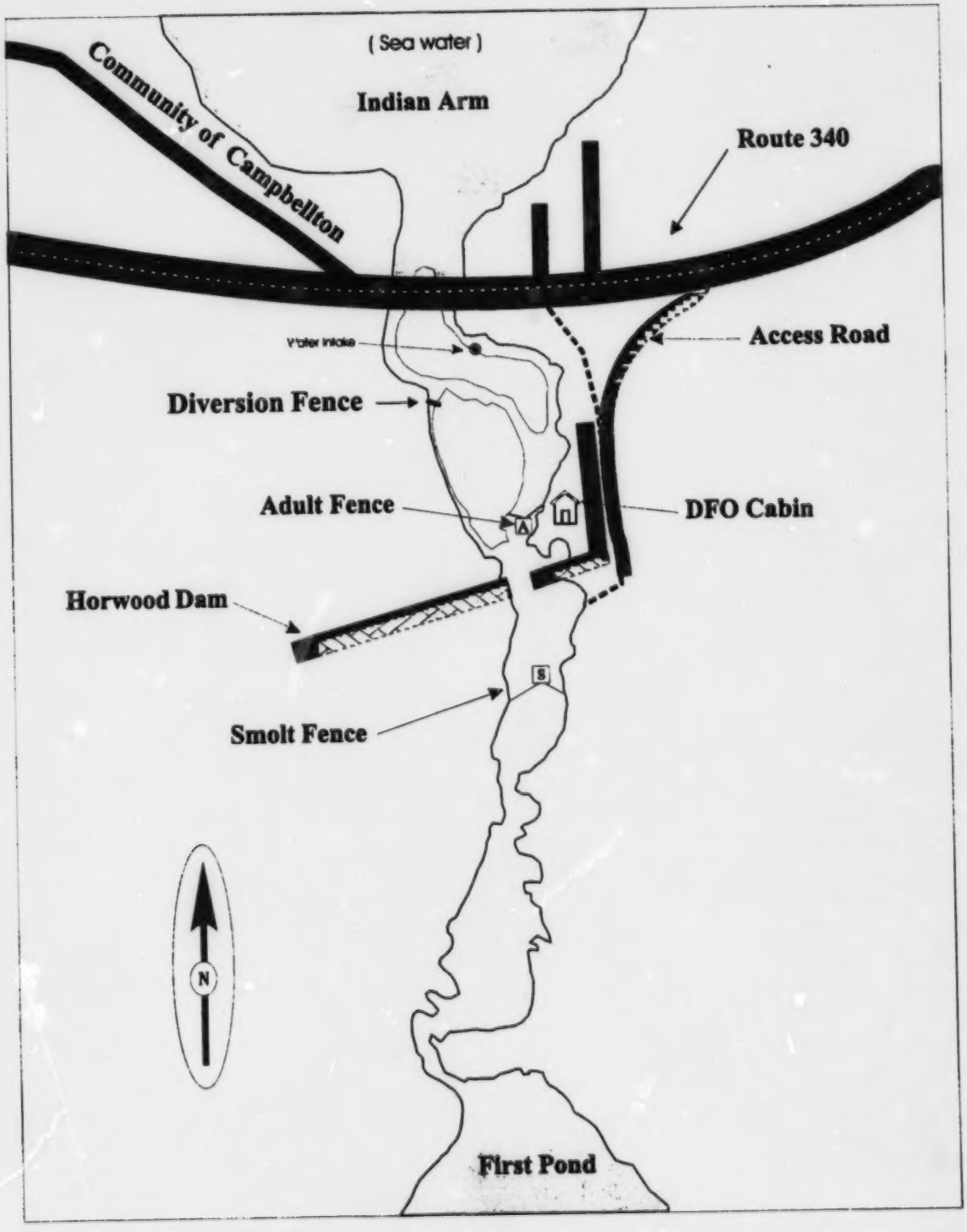


Figure 2. Campbellton River showing locations of smolt and adult counting fences.

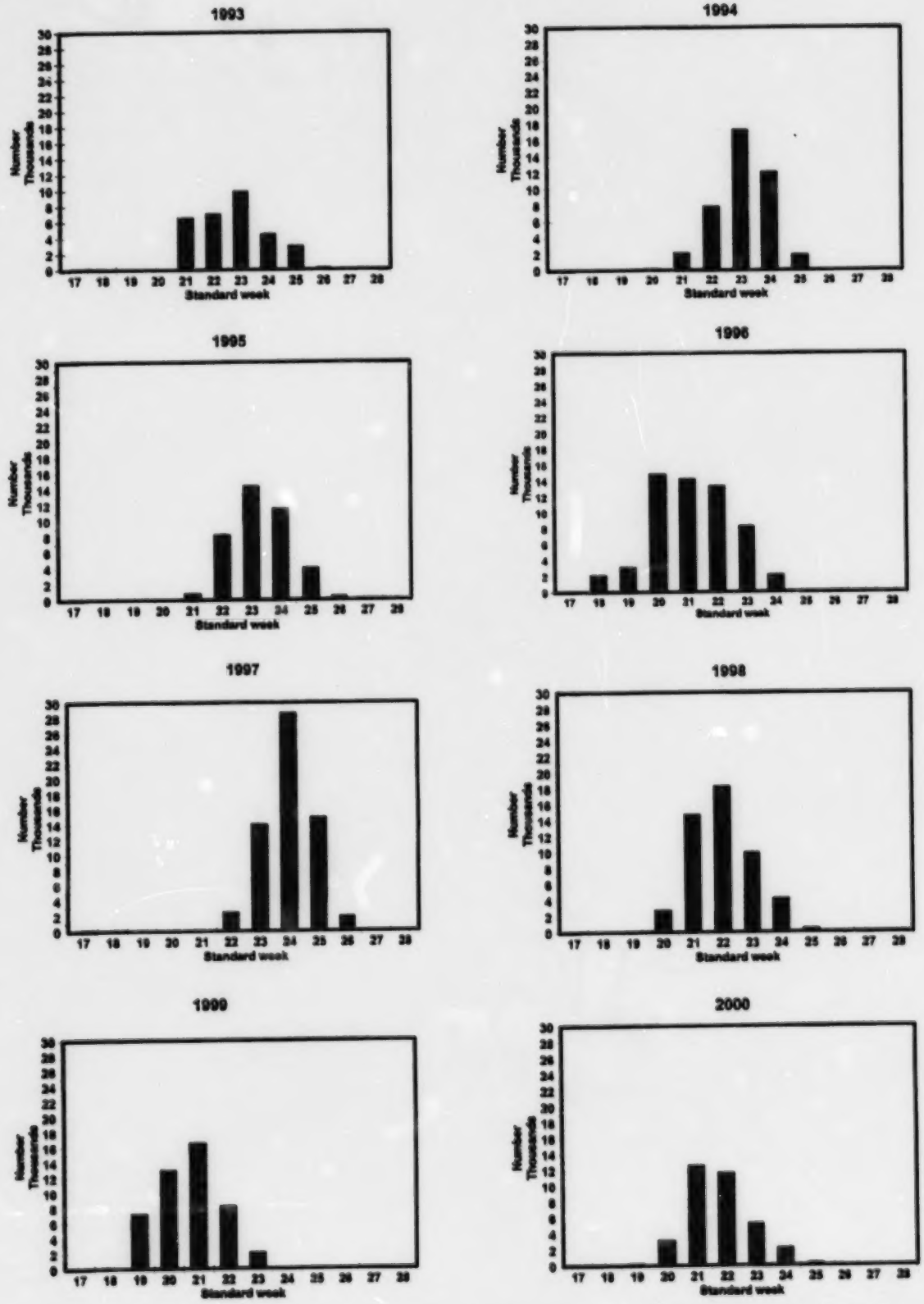


Figure 3. Downstream smolt migration at Campbellton River by standard week, 1993 - 2000.

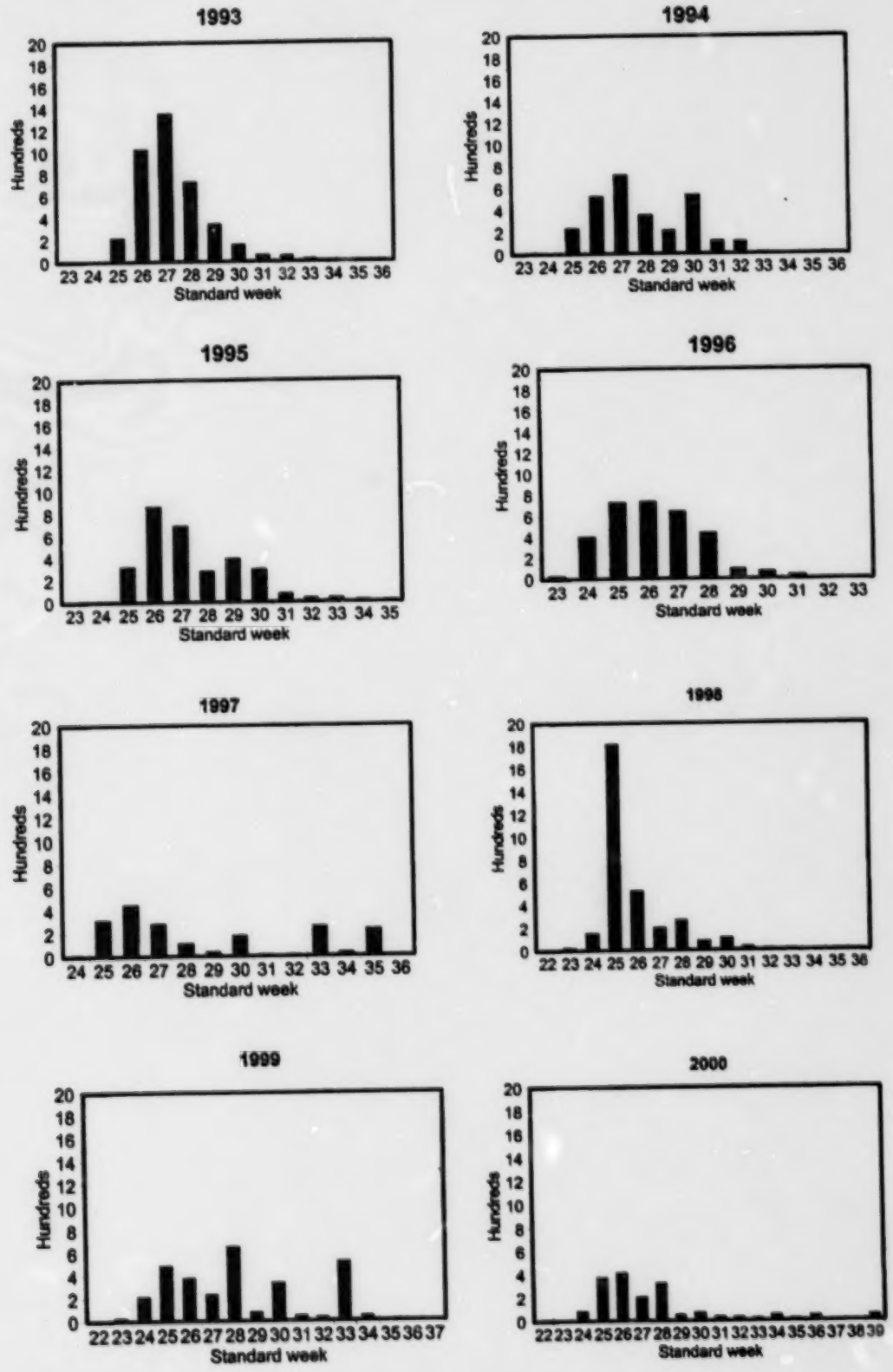


Figure 4. Adult small salmon upstream migrations by standard week enumerated at the counting fence, Campbellton River, 1993-2000.

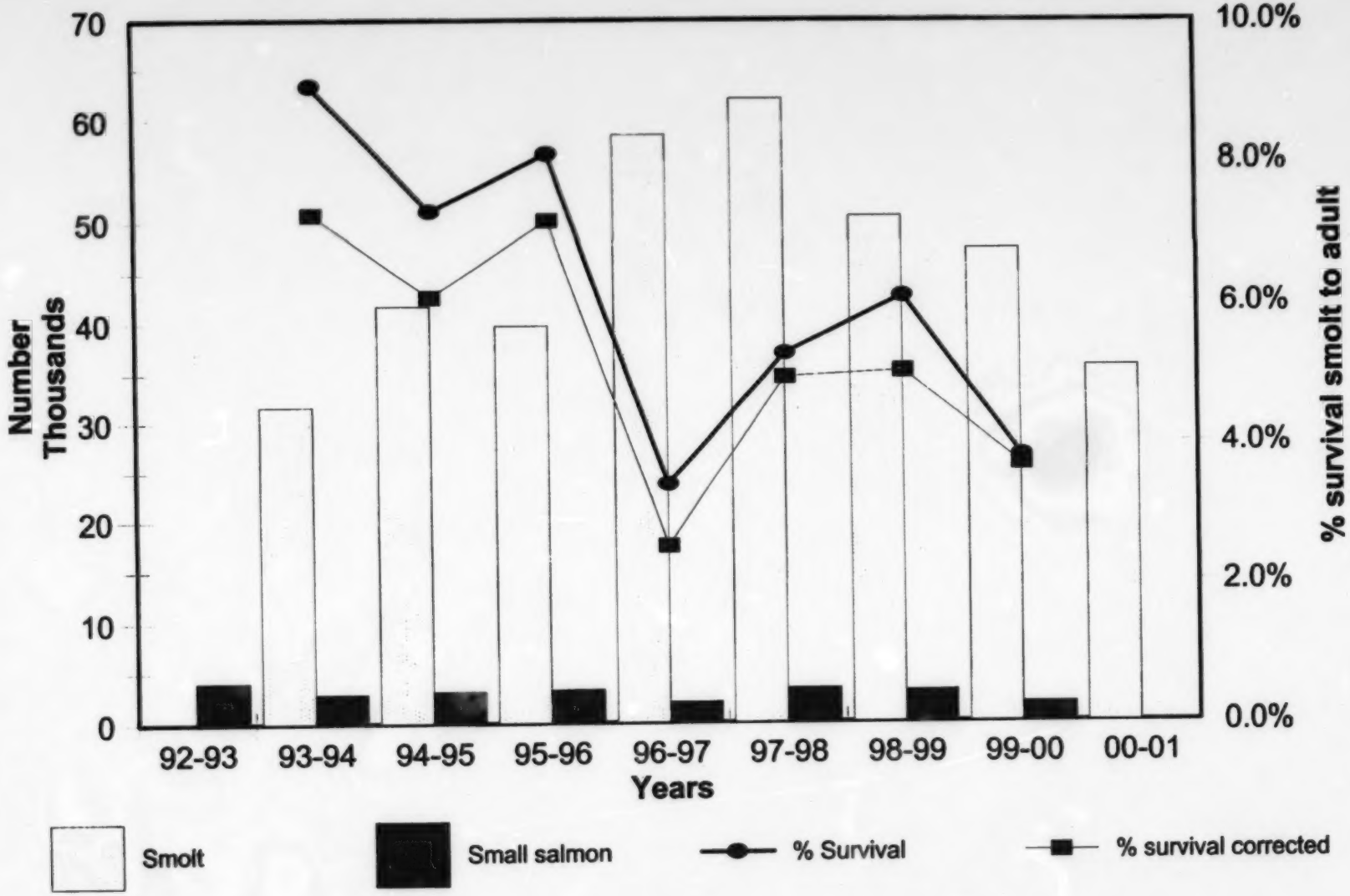


Figure 5. Smolt and small salmon Salmon migrations with percent survival (uncorrected and corrected for previous spawners) for Campbellton River, 1993 to 2000.

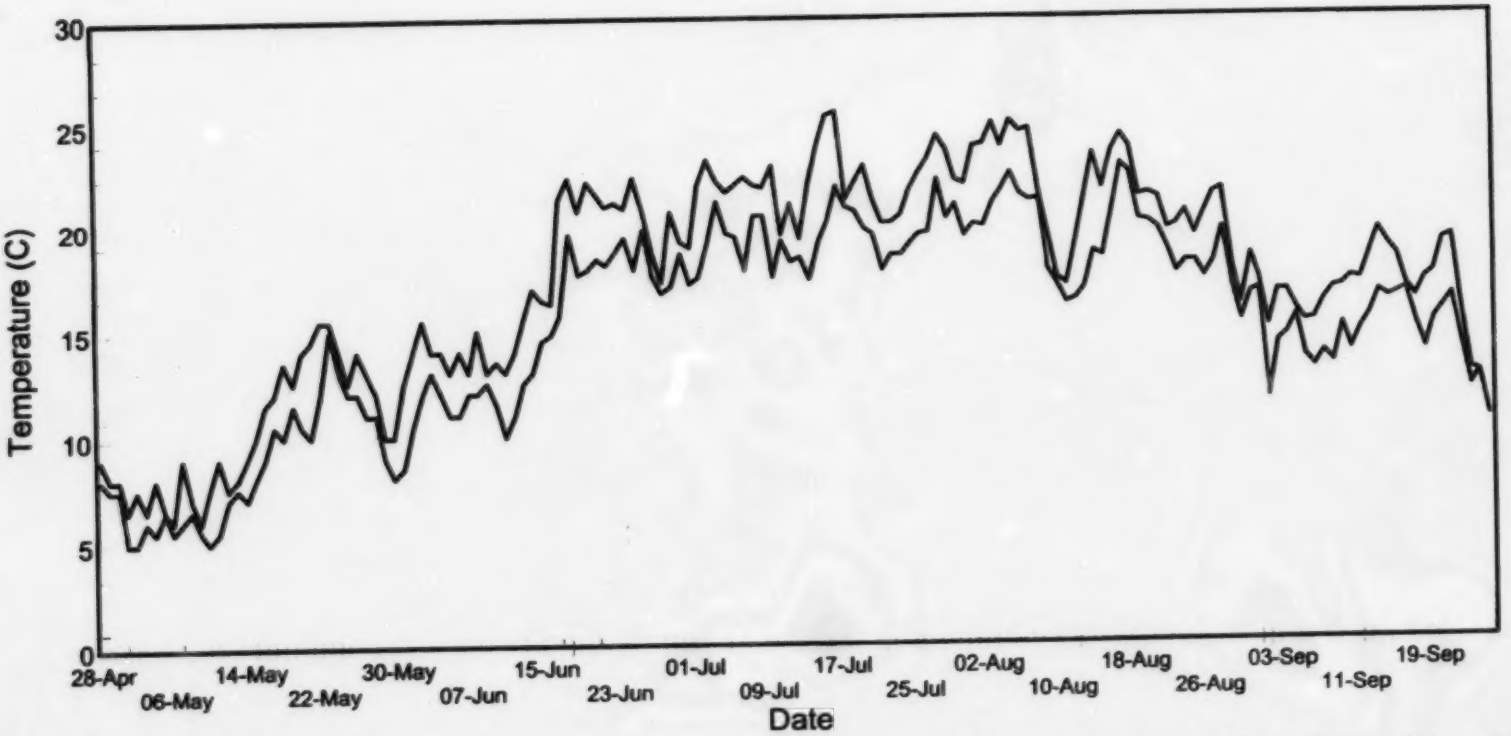


Figure 6. Daily maximum and minimum water temperatures taken near the counting fence at Campbellton River, 2000.

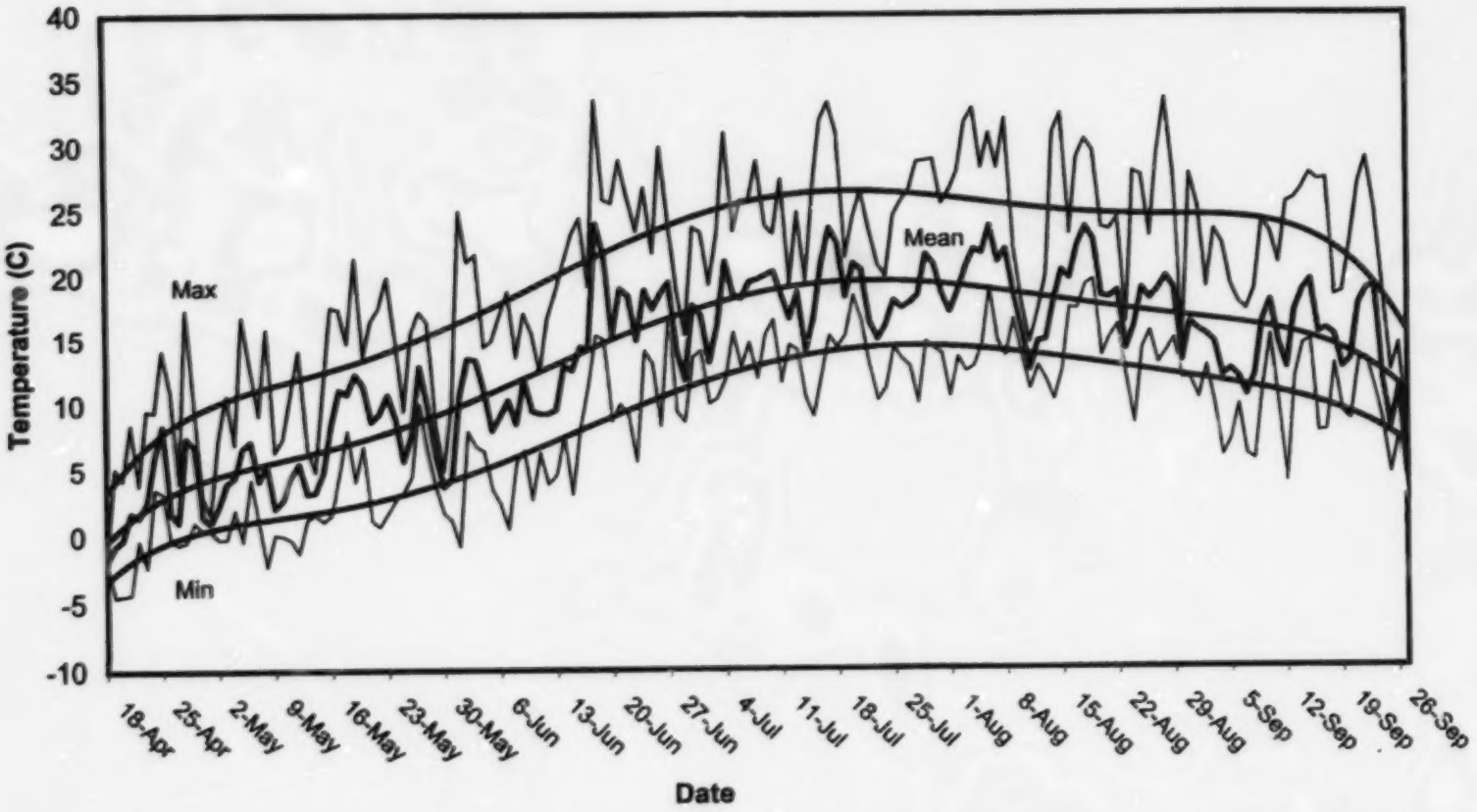


Figure 7. Air temperatures (max, min, and mean) with a 6th order polynomial trend lines applied, collected at Campbellton River , 2000.

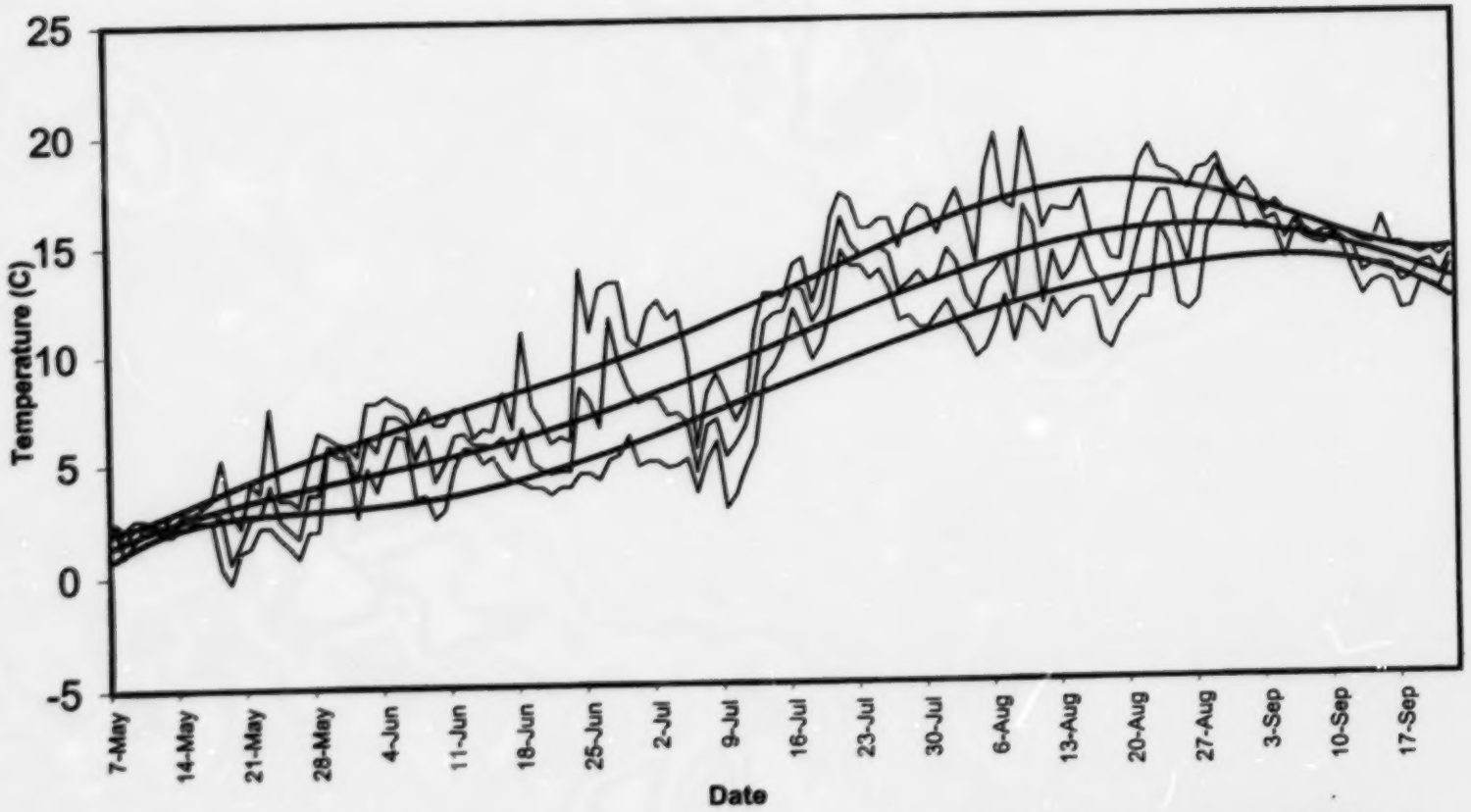
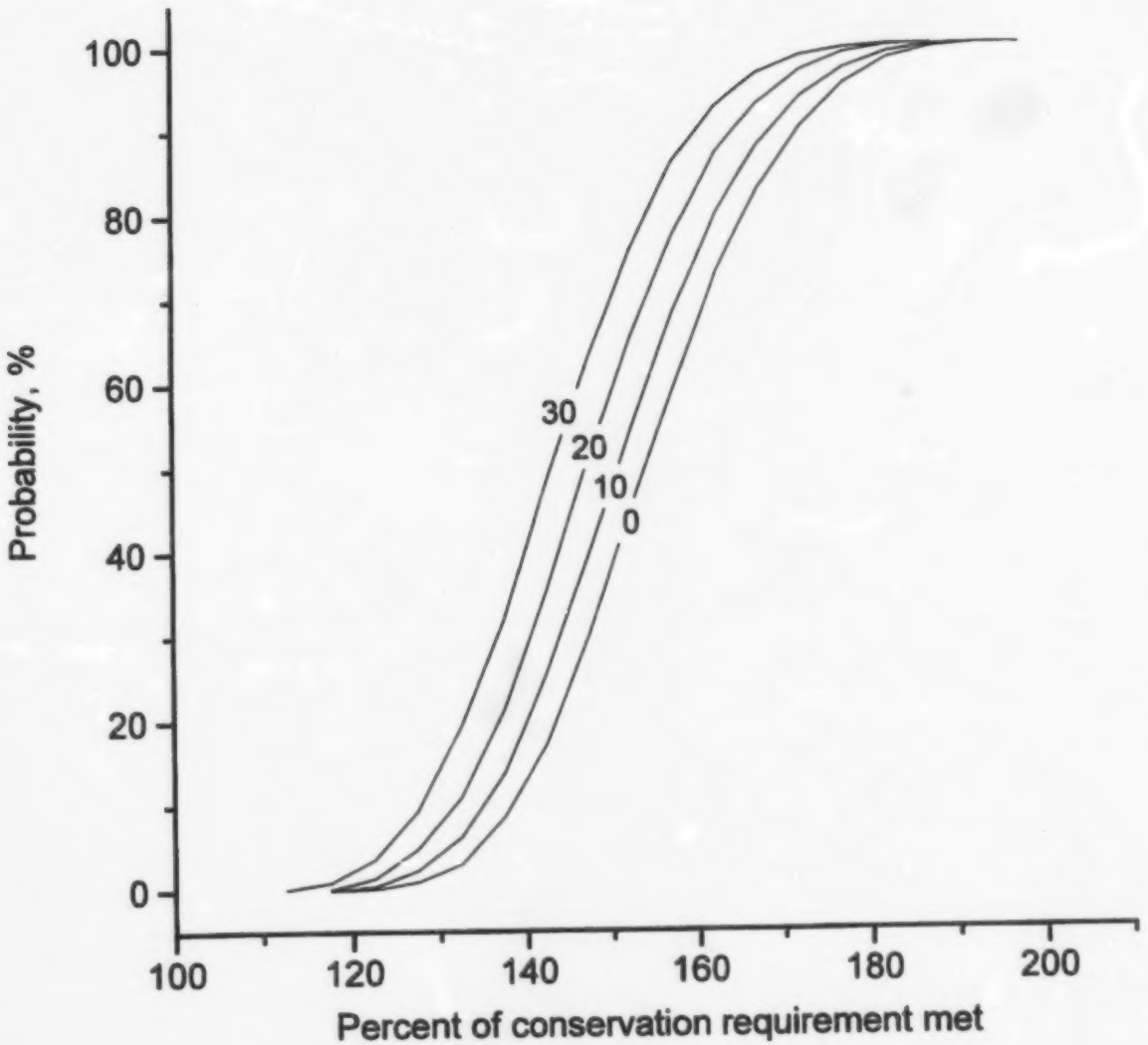


Figure 8. Sea temperatures (max, min and mean) taken at Indian Arm near the mouth of Campbellton River in 2000, with polynomial 6th order trendlines applied.

Fig. 9. Probability of achieving the conservation requirement for Campbellton River, 2000 at 0, 10, 20, and 30% angling exploitation on large salmon.



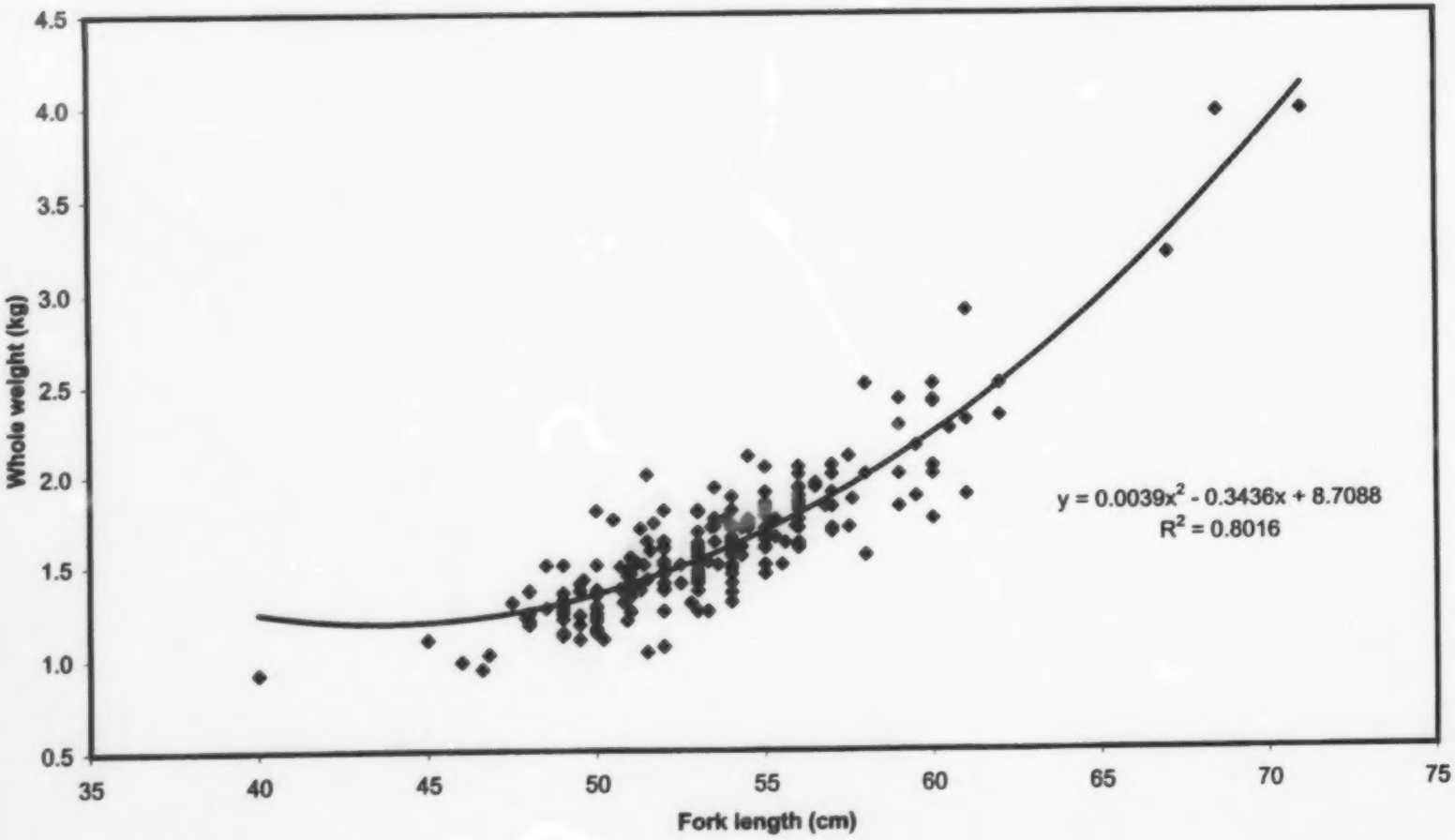


Figure 10. Polynomial regression of whole weight and fork length of 258 adult salmon caught in the recreational fishery at Campbellton River, 1992-2000.

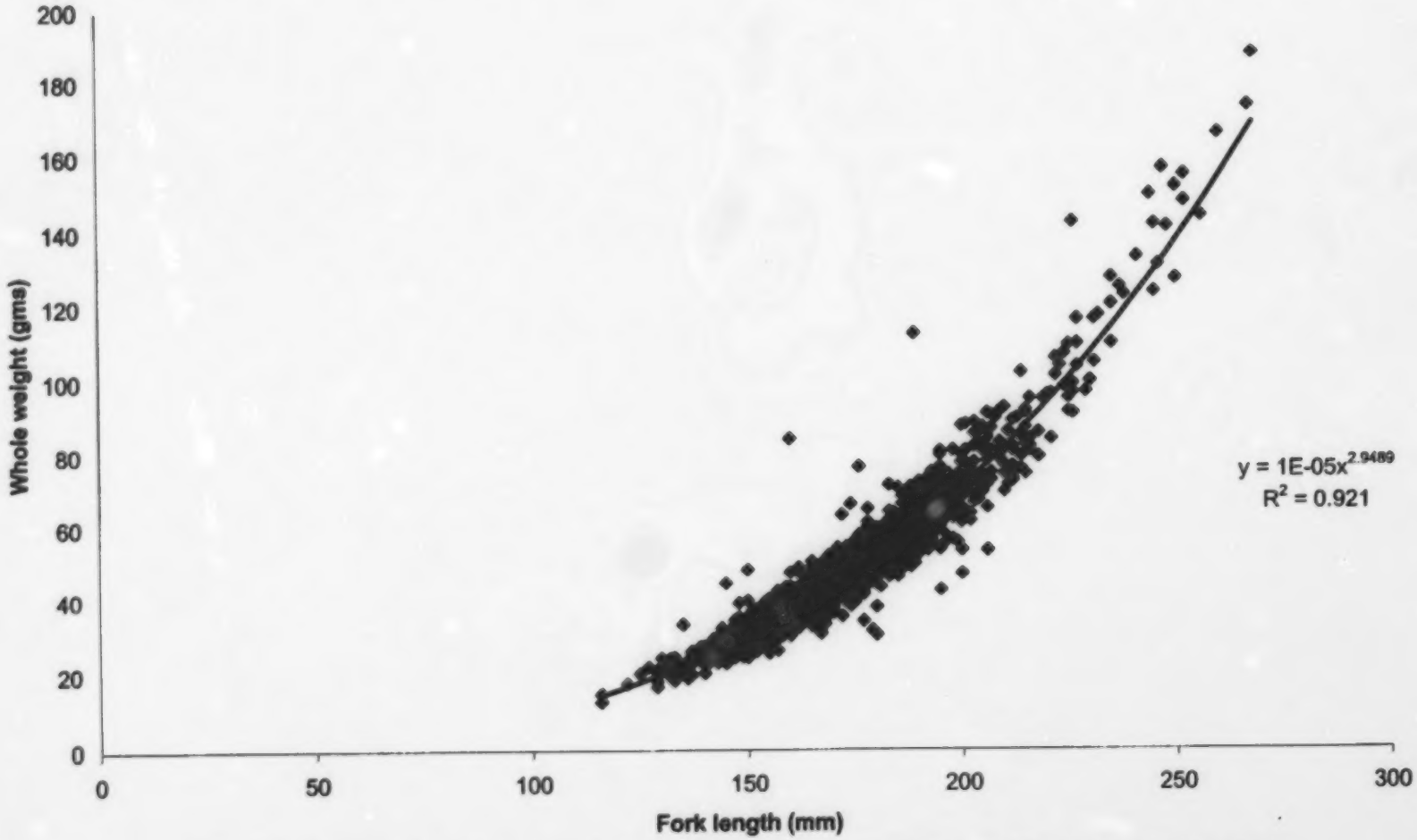


Figure 11. Regression of whole weight and fork length of smolt sampled from the counting fence at Campbellton River 1993-2000

Fig. 12. Frequency distribution of the estimated egg deposition at Campbellton River, 2000 (lower panel) and the corresponding probability distribution (upper panel).

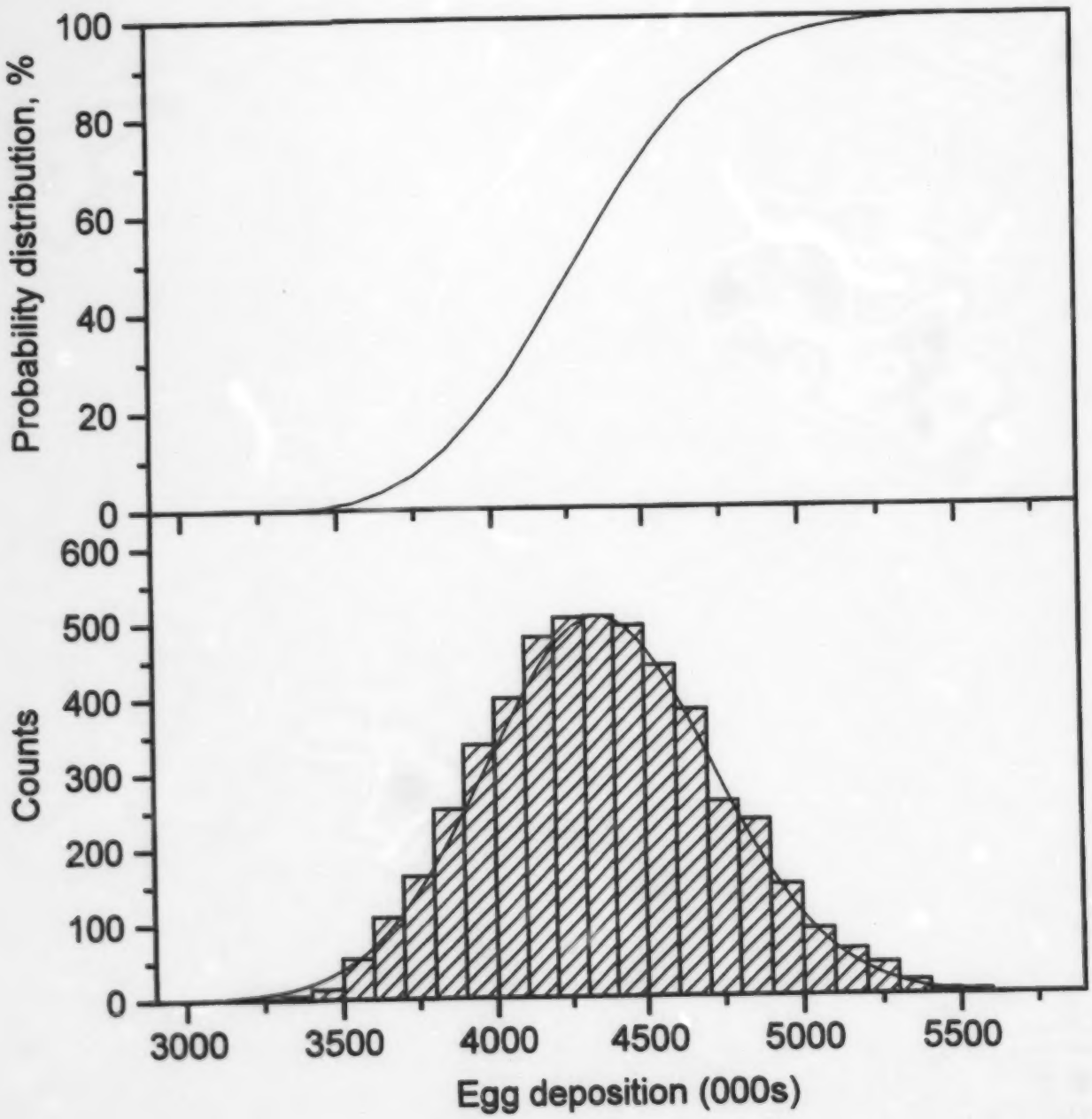


Fig. 13. Frequency distribution of the estimated percent of conservation requirements met at Campbellton River, 2000 (lower panel) and the corresponding probability distribution (upper panel).

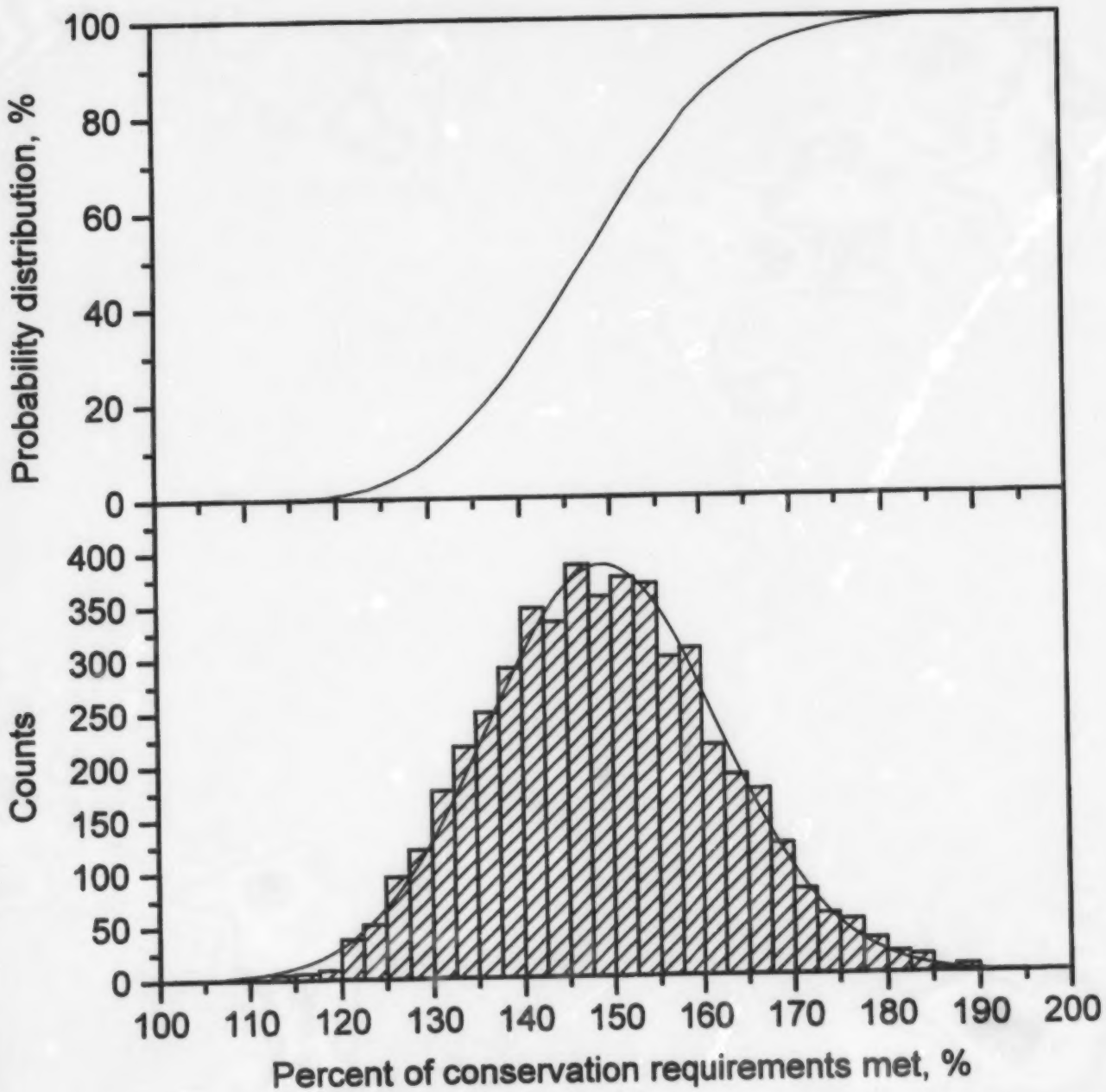


Fig. 14. Percent of scarred salmon at counting fence, Campbellton River, 1994-2000. Line is the 94-99 average.

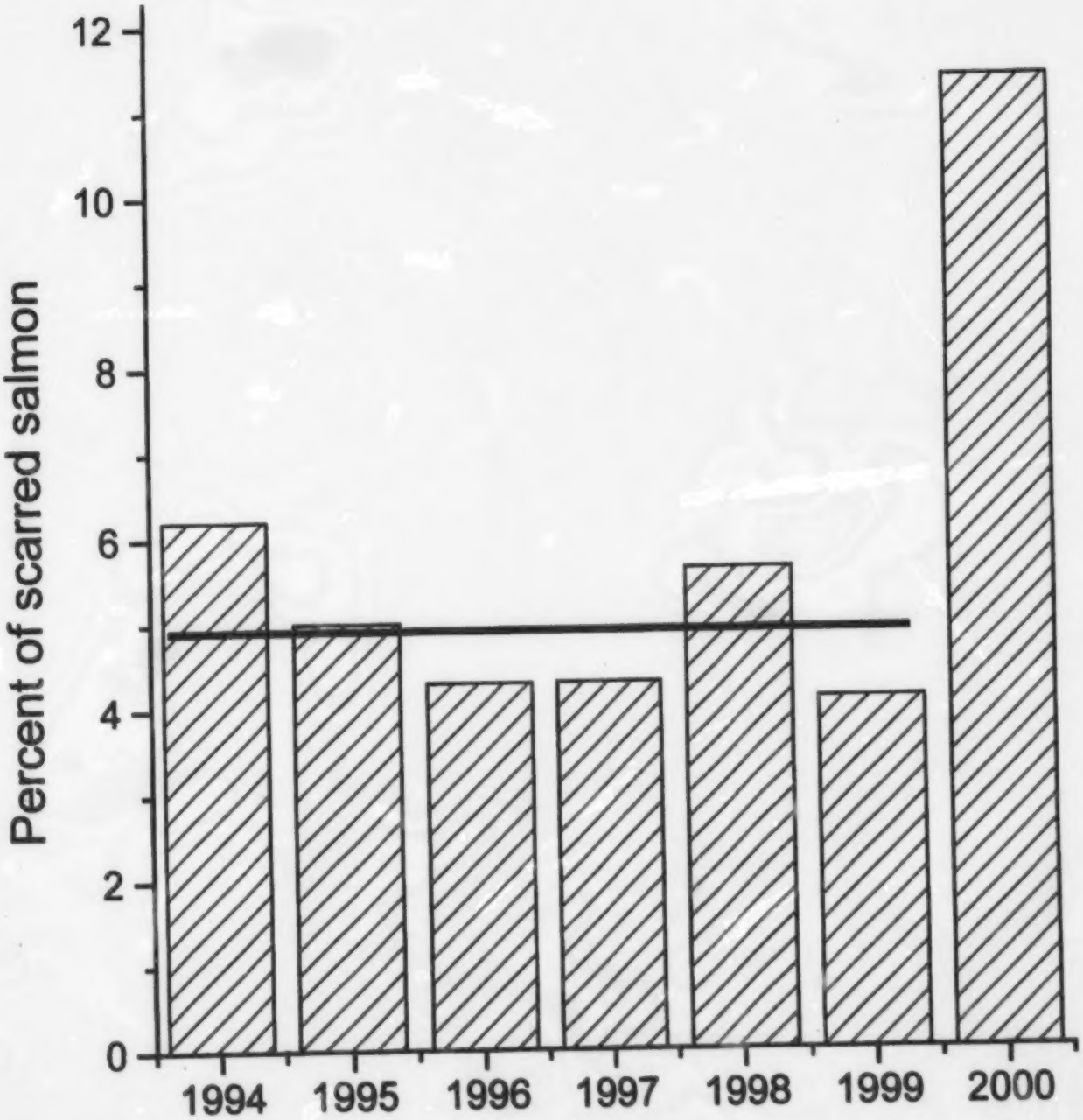


Fig. 15. Survival rates of kelts and smolts for year of return to Campbellton River, Nfld.

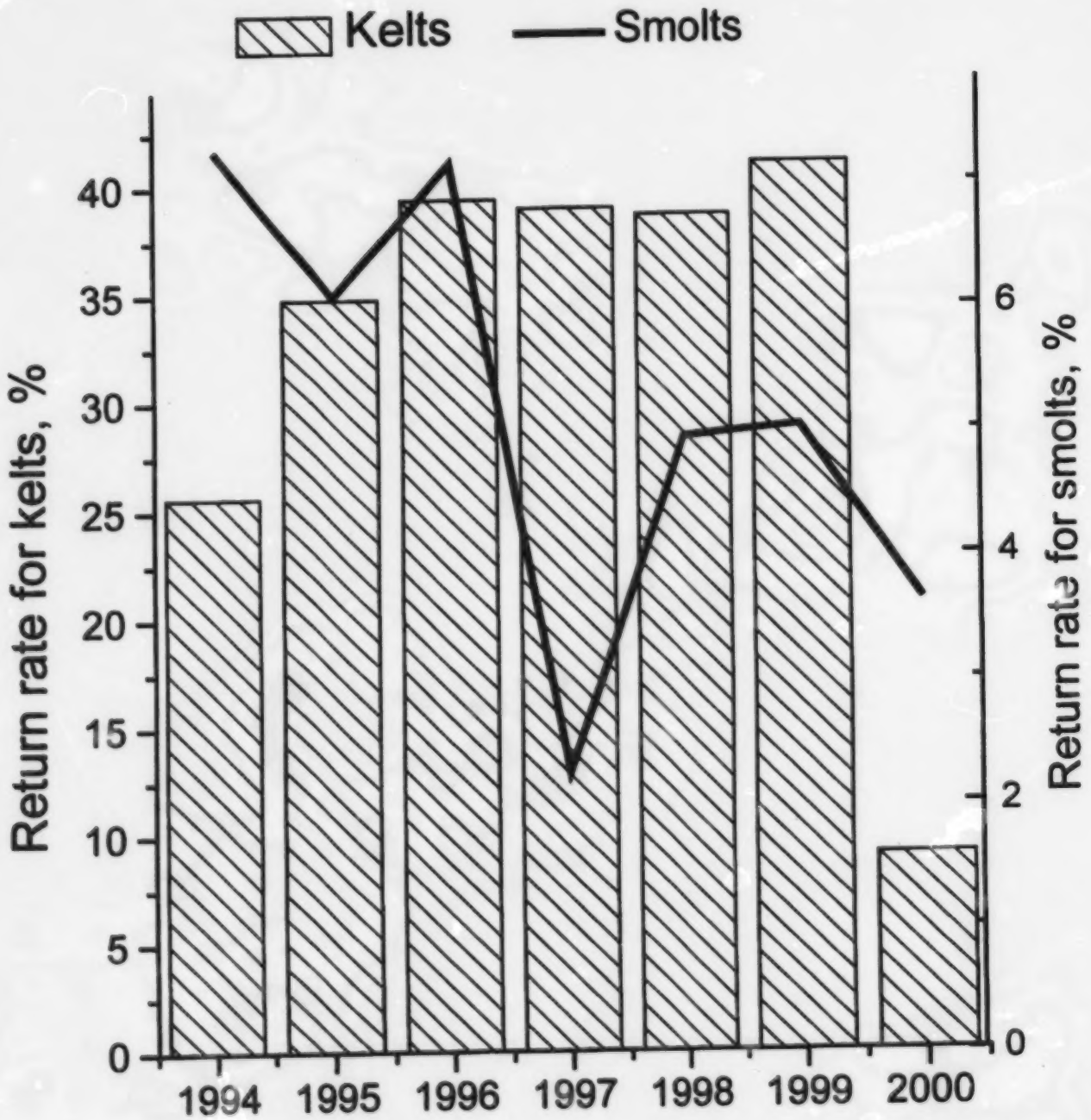


Table 1. The total rod days, total catch and catch per unit effort (CPUE) for both small and large Atlantic salmon angled in the recreational fishery for Insular Newfoundland ,Salmon Fishing Area 4 and the Campbellton River from 1953 to 2000.

	Rod days			Total catch (ret. + rel.)			CPUE		
Year	Insular Newfoundland	SFA 4	Campbellton River	Insular Newfoundland	SFA 4	Campbellton River	Insular Newfoundland	SFA 4	Campbellton River
1953	43,024	8,630	346	16,025	3,485	126	0.37	0.40	0.36
1954	28,505	7,344	587	8,705	1,600	102	0.31	0.22	0.17
1955	21,974	5,125	56	11,128	2,616	61	0.51	0.51	1.09
1956	53,092	10,672	341	16,702	4,350	119	0.31	0.41	0.35
1957	33,211	8,789	291	20,458	4,950	105	0.62	0.56	0.36
1958	34,444	5,888	592	20,844	5,001	447	0.61	0.85	0.76
1959	36,277	6,321	325	18,368	4,220	303	0.51	0.67	0.93
1960	35,750	7,051	313	17,336	3,950	265	0.48	0.56	0.85
1961	36,024	5,277	209	15,634	2,280	146	0.43	0.43	0.70
1962	49,035	8,842	397	24,808	4,879	147	0.51	0.55	0.37
1963	60,769	10,910	1,242	31,292	4,042	421	0.51	0.37	0.34
1964	71,541	15,608	1,066	39,276	7,917	496	0.55	0.51	0.47
1965	66,647	13,749	647	31,975	4,551	488	0.48	0.33	0.72
1966	66,414	15,249	881	30,605	6,627	689	0.46	0.43	0.78
1967	72,577	13,915	815	25,081	4,226	487	0.35	0.30	0.60
1968	75,575	15,318	1,577	31,303	6,139	743	0.41	0.40	0.47
1969	82,046	13,807	992	37,275	4,138	534	0.45	0.30	0.54
1970	84,912	15,759	680	32,592	4,896	437	0.38	0.31	0.66
1971	75,788	11,379	622	28,291	3,841	290	0.37	0.34	0.48
1972	69,219	10,778	452	25,804	3,468	210	0.37	0.32	0.46
1973	88,435	14,544	1,344	37,435	6,759	971	0.42	0.46	0.72
1974	108,199	22,038	1,956	27,698	5,455	505	0.26	0.25	0.26
1975	102,907	22,384	1,768	34,631	6,109	487	0.34	0.27	0.28
1976	115,847	24,787	2,042	35,514	6,871	834	0.31	0.28	0.41
1977	111,836	28,117	2,134	37,107	9,482	912	0.33	0.34	0.43
1978	96,659	24,131	1,314	30,182	9,276	429	0.31	0.38	0.33
1979	82,578	21,496	53	31,730	8,353	23	0.38	0.39	0.43
1980	104,332	25,172	2,293	37,771	9,921	1,112	0.36	0.39	0.48
1981	122,476	32,282	2,950	48,039	13,897	1,549	0.39	0.43	0.53
1982	129,369	32,929	1,874	43,119	10,231	473	0.33	0.31	0.25
1983	126,306	26,649	1,619	33,802	9,251	587	0.27	0.35	0.37
1984	121,979	29,633	2,657	39,842	9,915	992	0.33	0.33	0.37
1985	120,030	34,329	3,219	36,867	12,190	782	0.31	0.36	0.24
1986	123,528	31,650	1,791	38,204	9,293	422	0.31	0.29	0.24
1987	85,969	18,564	803	24,892	5,453	169	0.29	0.29	0.21
1988	120,497	27,413	1,837	40,441	9,854	636	0.34	0.36	0.35
1989	91,286	17,767	854	18,845	3,786	148	0.20	0.21	0.17
1990	105,736	23,533	693	30,470	5,661	106	0.29	0.24	0.15
1991	89,812	21,999	693	20,865	4,892	126	0.23	0.22	0.18
1992	95,931	19,485	916	30,173	6,810	341	0.31	0.35	0.37
1993	125,661	30,596	1,355	42,736	13,114	419	0.34	0.43	0.31
1994	141,508	43,242	1,484	39,381	12,158	345	0.28	0.28	0.23
1995	143,275	38,717	1,775	40,818	11,329	441	0.28	0.31	0.25
1996		44,385	1,984	57,825	17,566	587		0.40	0.30
1997 **				36,176	6,152	330			
1998 **				44,745	14,342	664			
1999 **				37,122	12,019	436			
2000 **				29,133	5,203	238			
Mean (1953-2000)	84,907	19,642	1,173	31,020	7,136	482			
Mean percent of Island		23.1%	1.4%		23.0%	1.5%			
Campbellton River to mean percent of SFA 4			5.97%			6.33%			

+ Note: recreation fishing closures occurred for SFA 4, therefore catch and effort are only a partial figures

** data obtained from the License Stub Return; 2000 figures are preliminary

Table 2. Atlantic salmon recreational statistics for Campbellton River, Notre Dame Bay, SFA 4, 1974-2000.

River: Campbellton River Code: 0708210

Year	Effort Rod Days	Small (<63 cm) Ret.	Rel.	Tot.	Large (>=63 cm) Ret.	Rel.	Tot.	Total (Small + Large) Ret.	Rel.	Tot.	CPUE
1974	1956	505	.	505	0	.	0	505	.	505	0.26
1975	1768	424	.	424	63	.	63	487	.	487	0.28
1976	2042	834	.	834	0	.	0	834	.	834	0.41
1977	2134	895	.	895	17	.	17	912	.	912	0.43
1978	1314	426	.	426	3	.	3	429	.	429	0.33
1979	53	23	.	23	0	.	0	23	.	23	0.43
1980	2298	1112	.	1112	0	.	0	1112	.	1112	0.48
1981	2950	1547	.	1547	2	.	2	1549	.	1549	0.53
1982	1674	471	.	471	2	.	2	473	.	473	0.28
1983	1619	597	.	597	0	.	0	597	.	597	0.37
1984	2657	991	.	991	1	.	1	992	.	992	0.37
1985	3219	782	.	782	*	.	0	782	.	782	0.24
1986	1791	422	.	422	*	.	0	422	.	422	0.24
1987	803	169	.	169	*	.	0	169	.	169	0.21
1988	1837	636	.	636	*	.	0	636	.	636	0.35
1989	854	148	.	148	*	.	0	148	.	148	0.17
1990	693	106	.	106	*	.	0	106	.	106	0.15
1991	693	126	.	126	*	.	0	126	.	126	0.18
1992	916	311	30	341	*	0	0	311	30	341	0.37
1993	1355	316	103	419	*	0	0	316	103	419	0.31
1994	1484	340	4	344	*	1	1	340	5	345	0.23
1995	1775	393	47	440	*	1	1	393	48	441	0.25
1996	1964	463	93	556	*	31	31	463	124	587	0.30
1997**		254	67	321	*	9	9	254	76	330	
1998**		375	281	656	*	8	8	375	289	664	
1999**		288	126	414	*	22	22	288	148	436	
2000**		183	48	231	*	5	5	183	53	236	
84-89 $\bar{X}$	2071.6	595.8	.	595.8	.	.	.	596.0	.	596.0	0.29
95% CL	1123.4	403.8	.	403.8	.	.	.	404.2	.	404.2	0.10
N	5	5	0	5	0	0	0	5	0	5	5
86-91 $\bar{X}$	1173.6	287.6	.	287.6	.	.	.	287.6	.	287.6	0.25
95% CL	730.6	289.8	.	289.8	.	.	.	289.8	.	289.8	0.11
N	5	5	0	5	0	0	0	5	0	5	5
92-96 $\bar{X}$	1498.8	364.6	55.4	420.0	.	6.6	6.6	364.6	62.0	426.6	0.28
95% CL	501.7	79.3	52.1	109.1	.	16.9	16.9	79.3	62.1	124.1	0.06
N	5	5	5	5	0	5	5	5	5	5	5
97-99 $\bar{X}$		305.7	158.0	463.7		13.0	13.0	305.7	171.0	476.7	
95% CL		155.0	274.6	429.6		19.4	19.4	155.0	269.2	424.0	
N		3	3	3		3	3	3	3	3	

1987 DATA NOT INCLUDED IN MEAN.

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1992 - 1996 AND ON RETAINED FISH ONLY PRIOR TO 1992.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

**DATA WERE OBTAINED FROM THE LICENSE STUB RETURN ; 2000 DATA ARE PRELIMINARY.

Table 3. Number of fishers, gear units and catches of Atlantic salmon in the commercial fishery for SFA 4 and Insular Newfoundland and the mean for 1984-90 compared to 1991.

	Salmon fishing Area 4						Insular Newfoundland					
Year	Number of commercial fisherman	Gear units (91.5 m)	Catch (metric tons) Small	Catch (metric tons) Large	Catch (numbers) Small	Catch (numbers) Large	Number of commercial fisherman	Gear units (91.5 m)	Catch (metric tons) Small	Catch (metric tons) Large	Catch (numbers) Small	Catch (numbers) Large
1984	892	3,124	73	50	38,857	10,976	3,065	11,008	241	240	130,131	54,283
1985	695	2,768	68	43	37,957	10,019	2,480	9,878	348	242	191,216	57,537
1986	696	2,782	119	81	59,902	17,047	2,480	9,916	392	282	200,267	60,699
1987	693	2,764	109	71	54,935	15,087	2,480	9,784	434	357	225,025	77,945
1988	682	2,728	68	35	36,016	8,179	2,380	9,520	249	191	134,562	43,581
1989	679	2,716	85	48	46,988	10,834	2,360	9,440	266	190	148,297	46,261
1990	669	2,674	62	31	32,648	6,940	2,320	9,270	171	180	92,554	39,497
Means (84-90)	715	2,794	83	51	43,900	11,297	2,509	9,831	300	240	160,293	54,258
1991	647	2,588	30	27	15,609	6,301	2,240	8,992	136	130	74,202	32,604
% drop in 1991 fishing, compared to 1984 to 1990 means	9.53%	7.36%	64.04%	47.35%	64.44%	44.23%	10.73%	8.53%	54.69%	45.90%	53.71%	39.91%

Note : In 1990 and 1991 a quota system was in placed and accounted for early closures for several SFA 's, during the fishing season, although set quota levels were not reached for SFA 4 and Insular Newfoundland for both years. Therefore slightly higher catches may have resulted in Insular Newfoundland.

Table 4. Daily count of downstream migrating fish at Campbellton River through the counting fence in 2000.

Date	Parr	Smolt	Kelt	Precocious * postsmolt	Ouananiche	Brook trout	Smelt	Eel
28-Apr	12	4	35	0	0	0	10	0
29-Apr	3	2	4	0	0	2	65	0
30-Apr	8	0	2	0	0	3	35	0
01-May	11	0	4	0	0	3	6	0
02-May	13	4	44	2	0	2	11	0
03-May	15	3	50	0	0	1	11	0
04-May	42	39	39	5	0	4	5	0
05-May	17	32	20	1	1	2	14	0
06-May	16	30	11	0	0	6	0	0
09-May	18	34	43	1	0	2	1	0
08-May	21	50	24	1	0	1	0	0
09-May	13	11	3	0	0	1	0	0
10-May	21	17	1	0	0	1	0	0
11-May	17	48	76	1	0	0	4	0
12-May	13	35	28	3	0	3	1	0
13-May	16	37	71	7	0	4	0	0
14-May	8	45	201	5	2	5	1	0
15-May	13	103	93	4	0	0	0	0
16-May	16	166	90	3	0	5	1	0
17-May	10	340	83	3	2	7	0	0
18-May	14	675	87	7	1	14	2	0
19-May	3	645	240	5	2	12	1	0
20-May	5	1,209	25	2	1	6	1	0
21-May	8	2,005	42	3	1	9	3	0
22-May	9	1,710	27	4	0	3	4	0
23-May	5	525	12	5	0	5	6	0
24-May	6	1,379	6	0	0	9	10	0
25-May	0	2,547	4	0	0	5	17	0
26-May	1	3,276	17	3	0	2	17	0
27-May	2	1,112	8	0	0	3	10	1
28-May	4	2,931	45	6	0	3	15	0
29-May	6	1,100	37	4	0	4	14	0
30-May	3	489	3	0	0	4	13	0
31-May	7	1,751	8	0	0	1	6	0
01-Jun	6	1,512	11	0	0	3	6	0
02-Jun	6	2,256	33	0	0	1	15	0
03-Jun	6	1,625	15	0	0	3	4	0
04-Jun	6	963	11	2	0	3	2	0
05-Jun	2	569	11	0	0	4	1	0
06-Jun	2	757	11	0	0	2	3	0
07-Jun	0	1,042	1	0	0	0	1	0
08-Jun	2	545	8	0	0	2	2	2
09-Jun	0	826	9	0	0	1	1	0
10-Jun	2	594	0	1	0	2	2	0
11-Jun	1	420	0	0	0	0	3	0
12-Jun	0	376	0	0	0	3	1	0
13-Jun	2	615	0	0	0	0	0	0
14-Jun	15	418	2	0	0	1	3	1
15-Jun	3	125	0	0	0	0	0	0
16-Jun	0	141	0	0	0	0	0	0
17-Jun	0	120	0	0	0	0	0	0
18-Jun	0	148	0	0	0	0	0	0
19-Jun	0	159	0	0	0	0	0	0
20-Jun	0	31	2	0	0	0	0	0
Total	429	35,596	1,597	78	10	157	328	4

* Adult salmon that didn't spend a complete first year at sea after they left freshwater as smolts.

Table 5. Number and percent of smolt migrating downstream by standard week through the counting fence on the Campbellton River, 1993-2000.

Dates		Standard week	1993		1994		1995		1996		1997		1998		1999		2000		Mean	
			Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
April	23-29	17							44	0.08							6	0.02	6	0.01%
May	30-06	18			1	0.00			2,146	3.68					109	0.23	108	0.30	297	0.65%
	07-13	19			16	0.04	3	0.01	3,152	5.40			0	0.00	7,185	15.20	232	0.65	1,350	2.94%
	14-20	20	125	0.40	224	0.54	15	0.04	14,833	25.41	20	0.03	2,772	5.50	12,984	27.48	3183	8.94	4,509	9.84%
	21-27	21	6,607	20.92	2,137	5.13	826	2.08	14,243	24.40	90	0.15	14,743	29.23	16,592	35.11	12554	35.27	9,187	20.04%
	28-03	22	7,071	22.39	7,842	18.82	8,228	20.72	13,358	22.89	2,491	4.01	18,322	36.32	8,243	17.44	11664	32.77	10,834	23.64%
June	04-10	23	9,915	31.40	17,297	41.52	14,409	36.28	8,264	14.16	14,017	22.59	9,957	19.74	2,143	4.53	5296	14.88	9,512	20.75%
	11-17	24	4,518	14.31	12,091	29.02	11,566	29.12	2,156	3.69	28,641	46.16	4,202	8.33			2215	6.22	6,897	15.05%
	18-24	25	3,012	9.54	1,876	4.50	4,020	10.12	121	0.21	14,908	24.03	445	0.88			338	0.95	2,874	6.27%
	25-01	26	253	0.80	147	0.35	495	1.25	52	0.09	1,883	3.03							340	0.74%
July	02-08	27	76	0.24	32	0.08	98	0.25											23	0.05%
	09-15	28	0	0.00	0	0.00	55	0.14											8	0.02%
Total			31,577		41,663		39,715		58,369		62,050		50,441		47,256		35,596		45,833	
Start date for fence			14-May		05-May		08-May		24-Apr		18-May		13-May		29-Apr		28-Apr			
End date for fence			10-Jul		12-Jul		15-Jul		30-Jun		01-Jul		20-Jun		10-Jun		20-Jun			

Table 6. The upsteam migration of Atlantic salmon adults through the counting fence on Campbellton River , 2000.

Date	Small	Large	Total
02-Jun	2	0	2
03-Jun	0	0	0
04-Jun	0	0	0
05-Jun	0	0	0
06-Jun	0	0	0
07-Jun	0	0	0
08-Jun	0	0	0
09-Jun	0	0	0
10-Jun	0	0	0
11-Jun	2	1	3
12-Jun	5	0	5
13-Jun	10	1	11
14-Jun	20	3	23
15-Jun	20	2	22
16-Jun	21	0	21
17-Jun	10	1	11
18-Jun	27	3	30
19-Jun	44	2	46
20-Jun	29	0	29
21-Jun	47	2	49
22-Jun	47	1	48
23-Jun	87	6	93
24-Jun	95	4	99
25-Jun	27	0	27
26-Jun	18	1	19
27-Jun	116	4	120
28-Jun	64	0	64
29-Jun	12	0	12
30-Jun	85	1	86
01-Jul	92	7	99
02-Jul	87	5	92
03-Jul	16	0	16
04-Jul	10	1	11
05-Jul	5	0	5
06-Jul	62	1	63
07-Jul	22	0	22
08-Jul	6	0	6
09-Jul	49	4	53
10-Jul	6	0	6
11-Jul	10	0	10
12-Jul	75	41	116
13-Jul	129	28	157
14-Jul	35	3	38
15-Jul	19	0	19
16-Jul	7	0	7
17-Jul	6	0	6
18-Jul	4	0	4
19-Jul	9	0	9
20-Jul	6	0	6
21-Jul	8	6	14
22-Jul	13	10	23
23-Jul	3	0	3
24-Jul	12	6	18
25-Jul	28	14	42
26-Jul	9	0	9
27-Jul	0	0	0
28-Jul	9	1	10
29-Jul	8	2	10
30-Jul	5	6	11
31-Jul	3	3	6

Table 6. The upsteam migration of Atlantic salmon adults through the counting fence on Campbellton River , 2000.

Date	Small	Large	Total
01-Aug	7	3	10
02-Aug	11	1	12
03-Aug	5	0	5
04-Aug	5	0	5
05-Aug	0	0	0
06-Aug	2	0	2
07-Aug	2	0	2
08-Aug	3	0	3
09-Aug	3	0	3
10-Aug	0	0	0
11-Aug	16	21	37
12-Aug	7	7	14
13-Aug	6	2	8
14-Aug	3	0	3
15-Aug	0	0	0
16-Aug	3	1	4
17-Aug	1	0	1
18-Aug	5	0	5
19-Aug	4	1	5
20-Aug	3	0	3
21-Aug	7	0	7
22-Aug	13	0	13
23-Aug	5	0	5
24-Aug	15	0	15
25-Aug	3	0	3
26-Aug	3	0	3
27-Aug	1	0	1
28-Aug	1	0	1
29-Aug	0	0	0
30-Aug	12	1	13
31-Aug	0	0	0
01-Sep	7	0	7
02-Sep	0	0	0
03-Sep	6	0	6
04-Sep	5	0	5
05-Sep	7	0	7
06-Sep	4	0	4
07-Sep	5	0	5
08-Sep	8	0	8
09-Sep	8	1	9
10-Sep	5	0	5
11-Sep	0	0	0
12-Sep	1	0	1
13-Sep	0	0	0
14-Sep	0	0	0
15-Sep	0	0	0
16-Sep	0	0	0
17-Sep	0	0	0
18-Sep	0	0	0
19-Sep	0	0	0
20-Sep	2	0	2
21-Sep	0	0	0
22-Sep	2	0	2
23-Sep	2	0	2
24-Sep	1	0	1
25-Sep	0	0	0
26-Sep	48	0	48
Total	1,798	208	2,006

Table 7. Number by standard week for upstream migration of adult Atlantic salmon through the counting facility on the Campbellton River, 1993-2000.

Dates		Standard week	1993		1994		1995		1996		1997		1998		1999		2000		1993 - 2000				
			Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Total	Mean	Percent
May	28-03	22											0	0	0	2	2	0	2	2	4	1	0.02
June	04-10	23							33	9			27	7	30	4	0	0	90	20	110	14	0.43
	11-17	24	14	0	3	0	4	2	405	42	16	6	156	33	216	17	88	8	902	108	1,010	126	3.92
	18-24	25	217	6	234	28	322	28	729	57	317	16	1,813	59	485	24	376	18	4,493	236	4,729	591	18.36
	25-01	26	1,023	40	525	11	867	30	737	97	450	12	525	27	377	24	414	13	4,918	254	5,172	647	20.08
July	02-08	27	1,351	42	721	22	693	13	645	161	284	1	199	46	236	35	208	7	4,337	327	4,664	583	18.10
	09-15	28	727	25	353	15	279	4	439	120	113	19	266	146	655	69	323	76	3,155	474	3,629	454	14.09
	16-22	29	340	12	215	19	394	35	93	46	42	10	86	30	79	20	53	16	1,302	188	1,490	186	5.78
	23-29	30	155	7	538	47	297	45	69	18	180	51	112	37	335	71	69	23	1,755	299	2,054	257	7.97
August	30-05	31	59	1	118	18	78	23	37	6	18	9	36	3	46	7	36	13	428	80	508	64	1.97
	06-12	32	53	4	114	17	39	23	10	3	18	8	19	10	33	9	33	28	319	102	421	53	1.63
	13-19	33	25	3	16	7	40	11	11	1	258	109	18	1	520	203	22	4	910	339	1,249	156	4.85
	20-26	34	17	2	13	1	19	4			34	11	12	3	43	6	49	0	187	27	214	27	0.83
	27-02	35	12	0	3	3	3	0			230	64	5	0	3	2	21	1	277	70	347	43	1.35
September	03-09	36	8	3	4	3					15	5	1	0	11	0	43	1	82	12	94	12	0.36
	10-16	37													7	0	6	0	13	0	13	2	0.05
	17-23	38															6	0	6	0	6	1	0.02
	24-30	39															49	0	49	0	49	6	0.19
Total			4,001	145	2,857	191	3,035	218	3,208	560	1,975	321	3,275	402	3,076	493	1,798	208	23,225	2,538	25,763		
Percent			96.5	3.5	93.7	6.3	93.3	6.7	85.1	14.9	86.0	14.0	89.1	10.9	86.2	13.8	89.6	10.4	90.1	9.9			
																	Mean		2,903	317	3,220		
Start date for adult fence			10-Jun		13-Jun		14-Jun		03-Jun		13-Jun		01-Jun		29-May		02-Jun						
End date for adult fence			07-Sep		12-Sep		29-Aug		20-Aug		08-Sep		08-Sep		14-Sep		26-Sep						

Table 8. Sea and freshwater survival rates of smolt to adult salmon and previous spawners from Campbellton River, 1994-2000.

Percent Survival	1994	1995	1996	1997	1998	1999	2000	Mean % 1994-2000
Smolt to small salmon uncorrected	9.05	7.28	8.08	3.38	5.28	6.10	3.80	6.14
Smolt to small salmon corrected for previous spawners	7.23	6.09	7.15	2.25	4.88	5.03	3.66	5.18
Percent difference (uncorrected to corrected)	20.11	16.35	11.51	33.43	7.58	17.54	3.68	15.74
Overwintering survival of spawners in freshwater	74.10	69.20	68.92	70.05	70.81	56.24	56.67	66.57
Previous spawners survival (<3 months) at sea	25.58	34.83	39.38	39.00	38.56	41.07	9.09	32.50

Due to the late installation of the smolt fence in 1998 an estimate of the kelt migration for 1998 was derived from data of previous years.

Table 9. Water quality results from samples collected near the mouth of Campbellton River in 1973, 1987, 1990, 1992, 1994 and 2000.

		Collection dates						
Parameter	Units	July, 1973	October 20, 1987	June 18, 1990	November 14, 1990	1992 (mean STD)* (May to November)	June 13, 1994	July 31, 2000
Alkalinity	mg/L $CaCO_3$	6.0	9.5	8.8	9.9		6.0	7.6
Apperent colour	TCU		15	44	42	40 (6.18)	40	n/a
Kjeldahl nitrogen	mg/L N		0.22	0.25	0.30		0.20	n/a
pH	Units	6.7	6.12	6.62	6.61	6.81 (0.11)	6.57	7.14
Total Phosphorus	mg/L PO_4		0.026	0.030	0.160		<0.02	<0.01
Specific Conductance	Micromhos/cm	23.0	40.0	21.2	34.2	28 (2.20)	19.3	38.5
Turbidity	NTU	0.8	0.60	0.36	0.28	0.5 (0.23)	0.55	0.23
Calcium	mg/L Ca	1.5	2.90	2.16	2.96		n/a	2.2
Magnesium	mg/L Mg		0.79	0.50	0.76		n/a	0.47
Sulphate	mg/L SO_4		3.3	1.8	3.0		n/a	0.8
Total Dissolved Solids	mg/L		46	35	44	22 (4.68)	18	25
Total suspended Solids	mg/L		<4	<4	<4	<4	<4	<2
Sodium	mg/L Na		3.4	2.88	2.51		n/a	2.68
Potassium	mg/L K		0.52	0.32	0.33		n/a	0.24

* The standard deviations for 14 reading from each month in 1992 values are indicated in brackets

Table 10. River age and percent of sampled smolts from 1993-2000 applied to the downstream smolt migrations for Campbellton River, 1993-2000.

	River age											
	2		3		4		5		6			
Year	No.	%	No.	%	No.	%	No.	%	No.	%	Total enumerated at fence	Total aged
1993	0	0.00	15,631	49.50	15,315	48.50	632	2.00	0	0.00	31,577	199
1994	171	0.41	25,931	62.24	12,620	30.29	2,766	6.64	171	0.41	41,663	241
1995	191	0.48	24,774	62.38	13,805	34.76	945	2.38	0	0.00	39,715	210
1996	671	1.15	34,975	59.92	20,050	34.35	2,673	4.58	0	0.00	58,369	262
1997	230	0.37	35,685	57.51	24,547	39.56	1,365	2.20	230	0.37	62,050	273
1998	212	0.42	22,658	44.92	25,009	49.58	2,562	5.08	0	0.00	50,441	236
1999	0	0.00	21,766	46.06	24,559	51.97	931	1.97	0	0.00	47,256	254
2000	0	0.00	15,648	43.96	17,883	50.24	1,890	5.31	171	0.48	35,596	207
Mean	175	0.37	25,364	53.62	19,962	42.20	1,712	3.62	76	0.16	47,303	235

Table 11. Mean fork length, whole weight and river age of salmon smolts taken randomly from the smolt fence at Campbellton River, 1993-2000.

Year	Sex	Fork length (mm)					Whole weight (grams)					Mean river age (years)				
		Mean	Number	STD	Min.	Max.	Mean	Number	STD	Min.	Max.	Mean	Number	STD	Min.	Max.
1993	Male	186.4	58	20.5	145.0	275.0	60.2	58	22.2	24.6	175.6	3.53	58	0.54	3	5
	Female	186.2	141	19.9	127.0	252.0	60.7	141	21.1	22.0	148.6	3.52	141	0.54	3	5
	All	186.3	199	20.1	127.0	275.0	60.6	199	21.37	22.0	175.6	3.52	199	0.54	3	5
1994	Male	172.1	49	14.2	140.0	200.0	48.0	49	12.5	24.7	88.2	3.40	48	0.64	3	5
	Female	173.0	196	18.6	135.0	267.0	49.4	196	18.0	21.8	174.0	3.46	193	0.64	2	6
	All	172.9	245	17.8	135.0	267.0	49.1	245	17.0	21.8	174.0	3.44	241	0.64	2	6
1995	Male	168.9	61	14.3	135.0	200.0	44.0	61	12.31	22.4	84.5	3.49	61	0.60	3	5
	Female	169.1	150	16.0	132.0	221.0	44.7	150	13.46	22.9	86.1	3.35	149	0.52	2	5
	All	167.1	211	15.5	132.0	221.0	44.5	211	13.11	22.4	86.1	3.39	210	0.54	2	5
1996	Male	174.0	80	16.5	147.0	227.0	47.1	80	15.34	24.8	116.9	3.49	79	0.60	3	5
	Female	176.0	183	20.6	130.0	256.0	50.0	183	19.74	19.1	155.6	3.39	183	0.60	2	5
	All	175.4	263	19.4	130.0	256.0	49.1	263	18.54	19.1	155.6	3.42	262	0.60	2	5
1997	Male	167.1	90	22.2	133.0	268.0	43.1	90	22.5	18.9	188.2	3.60	90	0.67	3	6
	Female	166.5	184	20.8	133.0	278.0	42.9	184	19.99	18.3	206.9	3.37	183	0.50	2	4
	All	166.7	274	21.3	133.0	278.0	43.0	274	20.81	18.3	206.9	3.45	273	0.57	2	6
1998	Male	171.7	57	13.7	144.0	209.0	46.3	57	12.27	26.5	92.3	3.58	57	0.60	3	5
	Female	170.3	176	22.2	122.0	250.0	48.5	176	21.59	17.5	152.5	3.57	176	0.57	2	5
	All	170.7	233	20.5	122.0	250.0	48.0	233	19.72	17.5	152.5	3.58	233	0.58	2	5
1999	Male	175.6	65	20.6	141.0	241.0	52.4	65	20.29	27.2	133.8	3.62	65	0.55	3	5
	Female	171.8	189	16.3	129.0	223.0	47.0	189	13.89	20.6	104.4	3.54	189	0.53	3	5
	All	172.8	254	17.5	129.0	241.0	48.4	254	15.90	20.6	133.8	3.54	254	0.54	3	5
2000	Male	177.3	61	20.6	116.0	247.0	52.3	61	21.00	14.6	157.3	3.59	61	0.59	3	5
	Female	174.6	147	21.6	116.0	260.0	50.4	147	21.12	12.6	166.5	3.61	147	0.69	2	6
	All	175.4	208	21.2	116.0	260.0	50.9	208	21.05	12.6	166.5	3.62	207	0.61	3	6
1993	Male	173.7	521	19.1	116.0	275.0	48.8	521	18.8	14.6	188.2	3.54	519	0.6	3	6
to	Female	173.1	1366	20.3	116.0	278.0	48.9	1366	19.3	12.6	206.9	3.48	1360	0.6	2	6
2000	All	173.3	1887	19.9	116.0	278.0	48.9	1887	19.2	12.6	206.9	3.50	1879	0.6	2	6

Table 12. Biological characteristics of small salmon sampled in the recreational fishery at Campbellton River, 1992-2000.

		Fork length (cm)					Whole weight (kgs)					River age (years)				
Year	Sex	Mean	Number	STD	Min	Max	Mean	Number	STD	Min	Max	Mean	Number	STD	Min	Max
1992	Male	55.80	4	3.97	52.0	60.0	1.83	3	0.58	1.50	2.50	3.50	4	1.00	3	5
	Female	53.85	13	4.93	43.5	62.5	1.75	2		1.75	1.75	3.38	13	0.51	3	4
	All	54.18	17	4.71	43.5	62.5	1.81	4	0.47	1.50	2.50	3.41	17	0.62	3	5
1993	Male	53.00	23	3.50	48.0	62.0	1.55	23	0.29	1.16	2.50	3.09	23	0.29	3	4
	Female	52.42	64	2.49	46.0	57.5	1.47	60	0.21	0.90	1.92	3.03	61	0.36	2	4
	All	52.58	87	2.78	46.0	62.0	1.50	83	0.23	0.90	2.50	3.05	84	0.34	2	4
1994	Male	55.76	10	3.13	52.5	60.5	1.79	10	0.36	1.40	2.31	3.17	12	0.39	3	4
	Female	52.71	31	3.13	46.3	60.5	1.56	26	0.26	0.94	2.18	3.25	32	0.51	3	5
	All	53.46	41	3.36	46.3	60.5	1.62	36	0.31	0.94	2.31	3.23	44	0.48	3	5
1995	Male	53.89	10	3.55	49.0	61.0	1.72	9	0.39	1.13	2.30	3.30	10	0.48	3	4
	Female	52.47	45	3.44	43.0	62.0	1.55	38	0.32	0.97	2.42	3.30	44	0.51	2	4
	All	52.69	55	3.46	43.0	62.0	1.58	47	0.33	0.97	2.42	3.30	54	0.50	2	4
1996	Male	50.83	3	1.87	48.5	52.0	1.44	3	0.10	1.33	1.50	3.50	2	0.71	3	4
	Female	51.50	6	4.23	45.0	56.0	1.58	5	0.41	1.10	2.10	3.33	6	0.52	3	4
	All	51.21	9	3.50	45.0	56.0	1.53	8	0.33	1.10	2.10	3.38	8	0.52	3	4
1997	Male	53.05	4	3.81	49.5	58.0	1.65	4	0.35	1.23	2.00	3.50	4	0.58	3	4
	Female	52.06	18	3.98	46.0	58.5	1.43	17	0.28	0.91	1.93	3.33	18	0.49	3	4
	All	52.26	22	3.86	46.0	58.0	1.48	21	0.30	0.91	2.00	3.36	22	0.49	3	4
1998	Male	54.50	2	2.12	53.0	56.0	1.69	2	0.15	1.58	1.80	3.50	2	0.71	3	4
	Female	53.30	21	2.66	49.5	60.0	1.53	20	0.23	1.13	2.04	3.44	18	0.51	3	4
	All	53.40	23	2.60	49.5	60.0	1.54	22	0.30	1.13	2.04	3.45	20	0.51	3	4
1999	Male	55.16	12	3.86	50.8	61.0	1.77	12	0.42	1.36	2.90	3.90	10	0.74	3	5
	Female	54.47	29	3.26	48.0	60.5	1.68	32	0.37	1.10	2.50	3.61	31	0.50	3	4
	All	54.67	41	3.40	48.0	61.0	1.71	44	0.38	1.10	2.90	3.68	41	0.57	3	5
2000	Male		0					0					0			
	Female	54.57	7	2.42	51.5	57.5	1.69	6	0.29	1.42	2.10	3.71	7	0.49	3	4
	All	54.57	7	2.42	51.5	57.5	1.69	6	0.29	1.42	2.10	3.71	7	0.49	3	4
1992-2000	Male	54.01	88	3.53	48.0	62.0	1.67	88	0.36	1.13	2.90	3.33	87	0.56	3	5
	Female	52.89	234	3.26	46.0	62.5	1.55	207	0.29	0.91	2.50	3.31	231	0.56	2	7
	All	53.14	302	3.36	46.0	62.5	1.58	273	0.31	0.91	2.90	3.32	298	0.56	2	7

Table 13. River age and percent of salmon sampled in the recreational fishery or from the adult counting fence at Campbellton River, 1992-2000.

		River age												
		2		3		4		5		6		7		
Year	Size *	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Total
1992	small	1	4.55	15	68.18	5	22.73	1	4.55	0	0.00	0	0.00	22
1993	small	4	4.60	75	86.21	8	9.20	0	0.00	0	0.00	0	0.00	87
1994	small	0	0.00	35	79.55	8	18.18	1	2.27	0	0.00	0	0.00	44
1995	small	1	1.85	36	66.67	17	31.48	0	0.00	0	0.00	0	0.00	54
1996	small	0	0.00	5	55.56	4	44.44	0	0.00	0	0.00	0	0.00	9
1997	small	0	0.00	14	63.64	8	36.36	0	0.00	0	0.00	0	0.00	22
1998	large	0	0.00	17	62.96	7	25.93	3	11.11	0	0.00	0	0.00	27
	small	0	0.00	19	46.34	17	41.46	4	9.76	0	0.00	1	2.44	41
1999	large	0	0.00	0	0.00	1	50.00	1	50.00	0	0.00	0	0.00	2
	small	0	0.00	17	39.53	24	55.81	2	4.65	0	0.00	0	0.00	43
2000	small	0	0.00	2	28.57	5	71.43	0	0.00	0	0.00	0	0.00	7
Total		6	1.68	235	65.64	104	29.05	12	3.35	0	0.00	1	0.28	358

* Size ; small (< 63 cm) & large (=> 63 cm)

Table 14. Percent male and female of adult salmon sampled from the recreational fishery and smolt sampled from the trap at Campbellton River, 1992-2000.

	Male				Female			
	Adult		Smolt		Adult		Smolt	
Year	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1992	4	23.53			13	76.47		
1993	23	26.44	58	29.15	64	73.56	141	70.85
1994	12	27.27	48	19.92	32	72.73	193	80.08
1995	10	18.18	61	29.05	45	81.82	149	70.95
1996	3	33.33	79	30.15	6	66.67	183	69.85
1997	4	18.18	90	32.97	18	81.82	183	67.03
1998	2	8.33	57	24.46	22	91.67	176	75.54
1999	12	26.09	65	25.59	34	73.91	189	74.41
2000	0	NA	61	29.33	8	100.00	147	70.67
Mean	70	22.44	519	27.61	242	77.56	1361	72.39

NA - not available due to low sample size.

Table 15. Campbellton River adult salmon returns, spawning escapement and egg deposition, 1993-2000.

SPAWNING ESCAPEMENT $SE = (FR) - (PPS + RCT + HRM)$

SE= Spawning escapement
FR= Fish released by counting fence
PPS= Precicious postsmolts
RCT= Recreational catch (retained)
RCL= Recreational catch (released)
HRM= Recreational mortality (RCL *0.1)

(Since precocious postsmolts are considered a separate category of small salmon and were substracted) from the upstream adult salmon migration until their spawning contribution is determined.)

		1993	1994	1995	1996	1997	1998	1999	2000	Average (1993-1999)
FR	Small	4001	2857	3035	3208	1975	3275	3076	1798	3061
	Large	145	191	218	560	321	402	493	208	333
PPS	Small < 40 cm	n/a	n/a	13	49	69	51	83	208	38
RCL	Small	103	4	47	93	67	281	126	48	103
	Large	0	1	1	31	9	8	22	5	10
HRM	Small	10	0	5	9	7	28	13	5	10
	Large	0	0	0	3	1	1	2	1	1
RCT	Small	316	340	393	483	254	375	288	183	347
	Large	0	0	0	0	0	0	0	0	0
SE	Small	3675	2517	2624	2687	1645	2821	2692	1402	2666
	Large	145	191	218	557	320	401	491	208	332

EGG DEPOSITION $ED = SE * PF * RF * MW$

ED= Egg deposition
SE= Spawning escapement
PF= Proportion females
RF= Relative fecundity (eggs/kg)
MW= Mean weight of females

	Year	1993	1994	1995	1996	1997	1998	1999	2000	Average (1993-2000)
SE	Small	3675	2517	2624	2687	1645	2821	2692	1402	2666
	Large	145	191	218	557	320	401	491	208	332
PF *	Small	0.736	0.727	0.818	0.776	0.776	0.776	0.739	0.776	0.764
	Large	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769
RF	Small	2100	2100	2100	2100	2100	2100	2100	2100	2100
	Large	2100	2100	2100	2100	2100	2100	2100	2100	2100
MW *	Small	1.47	1.56	1.55	1.55	1.43	1.53	1.68	1.55	1.54
	Large	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13
ED	Small	8344498	5996139	6987435	6786282	3834089	7033316	7019604	3541789	6571623
	Large	732922	964930	1101405	2814927	1617989	2027920	2480816	1046837	1677273
	% Large	8.1	13.9	13.6	29.3	29.7	22.4	26.1	22.8	20.3
Total		9077429	6961083	8088854	9601238	5452108	9061259	9500446	4588649	8248917
Conservation requirements		2916000	2916000	2916000	2916000	2916000	2916000	2916000	2916000	2916000
% requirements		311	239	277	329	187	311	326	157	283

*The PF and MW for large salmon are default values calculated from several rivers in Notre Dame Bay (O'Connell et al.1998).

*Due to low recreational sampling (< 25 fish) in 1996, 1997, 1998 and 2000 the MW and PF were derived means from combining the data from 1992-2000.

Table 16a. Summary of assessment of Campbellton River salmon stock based on upstream migrating adults. Based on a conservation requirement of 2,916,000 eggs.

Year	Fence count		Angling (catch and mortality at 10%)				Spawning escapement		Mean WW female		Percent female		Fecundity (eggs/kg)		Egg deposition		Total	Percent of conservation requirement
	Small	Large	Small	Mortality	Large	Mortality	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large		
1993	4,001	145	316	10	0	0	3674.7	145.0	1.47	3.13	0.736	0.769	2100	2100	8,344,498	732,922	9,077,421	311
1994	2,857	191	340	0	0	0	2516.6	190.9	1.56	3.13	0.727	0.769	2100	2100	5,996,139	964,930	6,961,069	239
1995	3,035	218	393	5	0	0	2637.3	217.9	1.55	3.13	0.818	0.769	2100	2100	7,023,765	1,101,405	8,125,171	279
1996	3,208	560	463	9	0	3	2735.7	556.9	1.55	3.13	0.776	0.769	2100	2100	6,906,488	2,814,927	9,721,415	333
1997	1,975	321	254	7	0	1	1714.3	320.1	1.43	3.13	0.776	0.769	2100	2100	3,992,822	1,617,989	5,610,811	192
1998	3,275	402	375	28	0	1	2871.9	401.2	1.53	3.13	0.776	0.769	2100	2100	7,156,783	2,027,920	9,184,703	315
1999	3,076	493	288	13	0	2	2775.4	490.8	1.68	3.13	0.739	0.769	2100	2100	7,236,980	2,480,816	9,717,796	333
2000	1,798	206	183	5	0	1	1610.2	207.5	1.55	3.13	0.776	0.769	2100	2100	4,065,075	1,048,837	5,113,913	175

Table 16b. Summary of assessment of Campbellton River salmon stock based on downstream migrating kelts from the next year. Based on a conservation requirement of 2,916,000 e

Year	Fence count		Angling catch and mortality at 10%				Spawning escapement		Mean FL		Percent female		Fecundity (eggs/kg)		Egg deposition		Total	Percent of conservation requirement
	Small	Large	Small	Mortality	Large	Mortality	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large		
1993	4,001	145	316	10	0	0	3,675	145	51.90	65.53	0.736	0.769	59.97	59.97	8,413,961	438,196	8,852,157	304
1994	2,857	191	340	0	0	0	2,517	191	53.08	65.37	0.727	0.769	59.97	59.97	5,827,225	575,801	6,403,025	220
1995	3,035	218	393	5	0	0	2,637	218	51.18	67.13	0.818	0.769	59.97	59.97	6,868,068	657,197	7,525,264	258
1996	3,208	560	463	9	0	3	2,736	557	51.94	68.83	0.776	0.769	59.97	59.97	6,754,899	1,679,168	8,434,067	289
1997	1,975	321	254	7	0	1	1,714	320	51.64	67.00	0.776	0.769	59.97	59.97	4,231,687	964,692	5,196,380	178
1998	3,275	402	375	25	0	1	2,875	401	51.35	68.67	0.776	0.769	59.97	59.97	7,098,075	1,208,880	8,306,956	285
1999	3,076	493	288	13	0	2	2,775	491	52.61	67.28	0.739	0.769	59.97	59.97	6,529,708	1,479,597	8,009,305	275
2000	1,798	206	183	13	0	2	1,602	206			0.776	0.769	59.97	59.97				

Note: Mean fork length of kelts are used to represent fork length of upsteam migrating adults from the previous year.

Table 17. Flesh scarring and net marked observed on the upstream migration of adult salmon on the Campbellotn River from 1994 to 2000.

Year	Upstream adult count	Number of scarred or netted adult salmon	Percent scarred or netted adult salmon
1994	3,048	189	6.20%
1995	3,253	173	5.32%
1996	3,768	162	4.30%
1997	2,296	99	4.31%
1998	3,677	214	5.82%
1999	3,569	147	4.12%
2000	2,006	228	11.37%
	21,617	1,212	5.61%

Table 18. Returns tags to the counting fence and other types of recaptures of Campbellton River tagged and released kelt, 1994-2000.

				Caught in the sea & freshwater outwith Campbellton River																		
		Returns to fence		Other areas		Sentinel cod fishery		Baitnet		Seals		Greenland		Angled		Total recoveries		Unaccounted for tags				
Year	Tagged	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Total	Number	Percent		
1994	942	241	25.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	1	0.1	242	700	74.3		
1995	600	209	34.8	1	0.2	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	2	0.3	211	389	64.8		
1996	584	230	39.4	2	0.3	0	0.0	7	1.2	0	0.0	0	0.0	0	0.0	9	1.5	239	345	59.1		
1997	459	179	39.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	180	279	60.8		
1998	236	91	38.6	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0	1	0.4	2	0.8	93	143	60.6		
1999	580	246	41.1	4	0.7	0	0.0	7	1.2	0	0.0	1	0.2	1	0.2	13	2.2	259	340	56.8		
2000	627	57	9.1	3	0.5	1	0.2	1	0.2	1	0.2	0	0.0	0	0.0	6	1.0	63	564	90.0		
Total	4847	1253	30.86	11	0.27	1	0.02	17	0.42	1	0.02	1	0.02	3	0.07	34	0.84	1287	2760	68.2		

Appendix 1

Sea survivial rates for Campbellton River Atlantic salmon (1994)

Sea survival rates for 93 smolt class:

			Year		
Smolt count for			1993	= 31,577	
Adult count	Small =	2,857	1994	Total= 3,048	
	Large=	191			
Sea survival rate from smolt to small salmon			1993-1994	= 9.05%	(uncorrected)

Previous spawners:

Kelts migration (downstream)	1994	= 2,838
Tagged kelt releases (downstream) (in 1993 = 942)	1994	= 942
Ratio untagged : tagged (total) kelts		= 3.01
Recreational salmon catch for	1993	= 316
Adult count	1993	= 4,146

Over-wintering kelt survival - 1993 to 1994

with recreational catch removed $\left(\frac{2{,}838}{4{,}146 - 316} \right)$ = 74.10%

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Upstream migration			
	Tagged	Est. previous Spawners	Total 1994	Percent previous spawners
Small	190	572	2,857	20.04%
Large	51	154	191	80.44%
Total	241	726	3,048	23.82%

Sea survival rates with correction for pervious spawners:

Smolt count for the year	1993	= 31,577
Upstream grilse only count for the year	1994	= 2,285
Previous spawners survival 3 months for	1994	= 25.58%
Corrected sea smolt survival for the year	1993	= 7.23%

Appendix 2

Sea survivial rates for Campbellton River Atlantic salmon (1995)

Sea survival rates for 94 smolt class:

			Year		
Smolt count for			1994	= 41,663	
Adult count	Small =	3,035	1995	Total = 3,253	
	Large=	218			
Sea survival rate from smolt to small salmon			1994-1995	= 7.28%	(uncorrected)

Previous spawners:

Kelts (downstream)		1995	= 1,874
Tagged kelt releases (downstream)		1995	Total = 600
(in 1995 =	448)		
(in 1994 =	152)		
Ratio untagged : tagged (total) kelts			= 3.12
Recreational salmon catch for		1994	= 340
Adult count		1994	= 3,048

Over-wintering kelt survival - 1994 to 1995

with recreational catch removed $\left(\frac{1,874}{3,048 - 340} \right)$ = 69.20%

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Upstream migration			
	Tagged	Est. previous Spawners	Total 1995	Percent previous spawners
Small	160	500	3,035	16.47%
Large	49	153	218	70.20%
Total	209	653	3,253	20.07%

Sea survival rates with correction for pervious spawners:

Smolt count for the year	1994	=	41,663
Upstream grilse only count for the year	1995	=	2,535
Previous spawners survival 3 months for	1995	=	34.83%
Corrected sea smolt survival for the year	1994	=	6.09%

Appendix 3

Sea survivial rates for Campbellton River Atlantic salmon (1996)

Sea survival rates for 95 smolt class:

			Year	
Smolt count for			1995	= 39,715
Adult count	Small =	3,208	1996	Total = 3,768
	Large=	560		
Sea survival rate from smolt to small salmon			1995-1996	= 8.08% (uncorrected)

Previous spawners:

Kelts (downstream)	1996	= 1,971
Tagged kelt releases (downstream)	1996	Total = 584
(in 1996 = 484)		
(in 1994-95 = 100)		
Ratio untagged : tagged (total) kelts		= 3.38
Recreational salmon catch for	1995	= 393
Adult count	1995	= 3,253

Over-wintering kelt survival - 1995 to 1996

with recreational catch removed $\left(\frac{1,971}{3,253 - 393} \right)$ = 68.92%

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Upstream migration			
	Tagged	Est. previous Spawners	Total 1996	Percent previous spawners
Small	109	368	3,208	11.47%
Large	121	408	560	72.92%
Total	230	776	3,768	20.60%

Sea survival rates with correction for perviou spawners:

Smolt count for the year	1995	=	39,715
Upstream grilse only count for the year	1996	=	2,840
Previous spawners survival 3 months for	1996	=	39.38%
Corrected sea smolt survival for the year	1995	=	7.15%

Appendix 4

Sea survivial rates for Campbellton River Atlantic salmon (1997)

Sea survival rates for 96 smolt class:

Smolt count for — Year 1996 = 58,369

Adult count — Small = 1,975; Large = 321 — 1997 — Total = 2,296

Sea survival rate from smolt to small salmon — 1996-1997 = 3.38% (uncorrected)

Previous spawners:

Kelts (downstream) — 1997 = 2,315

Tagged kelt releases (downstream) — 1997 — Total = 459
(in 1997 = 347)
(in 1994-96 = 112)

Ratio untagged : tagged (total) kelts = 5.04

Recreational salmon catch for — 1996 = 463

Adult count — 1996 = 3,768

Over-wintering kelt survival - 1996 to 1997

with recreational catch removed $\left(\frac{2,315}{3,768 - 463} \right)$ = 70.05%

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Upstream migration			
	Tagged	Est. previous Spawners	Total 1997	Percent previous spawners
Small	131	661	1,975	33.45%
Large	48	242	321	75.42%
Total	179	903	2,296	39.32%

Sea survival rates with correction for pervious spawners:

Smolt count for the year	1996	=	58,369
Upstream grilse only count for the year	1997	=	1,314
Previous spawners survival 3 months for	1996	=	39.00%
Corrected sea smolt survival for the year	1996	=	2.25%

Appendix 5

Sea survivial rates for Campbellton River Atlantic salmon (1998)

Sea survival rates for 97 smolt class:

			Year		
Smolt count for			1997	= 62,050	
Adult count	Small =	3,275	1998	Total = 3,677	
	Large=	402			
Sea survival rate from smolt to small salmon			1997-1998	= 5.28%	(uncorrected)

Previous spawners:

Kelts (downstream)	1998	= *1,446*	*
Tagged kelt releases (downstream) (in 1998 = 109) (in 1994-97 = 127)	1998	Total = *236*	*
Ratio untagged : tagged (total) kelts		= *6.13*	*
Recreational salmon catch for	1997	= 254	
Adult count	1997	= 2,296	

Over-wintering kelt survival - 1997 to 1998

with recreational catch removed $\left(\frac{1,446}{2,296 - 254} \right)$ = *70.81%* *

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Upstream migration			
	Tagged	Est. previous Spawners	Total 1998	Percent previous spawners
Small	40	245	3,275	*7.48%* *
Large	51	312	402	*77.73%* *
Total	91	558	3,677	*15.16%* *

Sea survival rates with correction for pervious spawners:

Smolt count for the year	1997	=	62,050
Upstream grilse only count for the year	1998	=	*3,030* *
Previous spawners survival 3 months for	1998	=	*38.56%* *
Corrected sea smolt survival for the year	1997	=	*4.88%* *

*** Due the late installation of the smolt fence, only 351 kelts were counted and is considered incomplete, therefore the kelt migration and those with tags attached from previous years were calculated by using ratios of kelts migrations and tagging from previous years.**

Appendix 6

Sea survivial rates for Campbellton River Atlantic salmon (1999)

Sea survival rates for 98 smolt class:

Smolt count for			Year 1998	= 50,411	
Adult count	Small =	3,076	1999	Total = 3,569	
	Large=	493			
Sea survival rate from smolt to small salmon			1998-1999	= 6.10%	(uncorrected)

Previous spawners:

Kelts (downstream)		1999	= 1,857
Tagged kelt releases (downstream)		1999	Total = 599
(in 1999 =	572)		
(in 1994-98 =	27)		
Ratio untagged : tagged (total) kelts			= 3.10
Recreational salmon catch for		1998	= 375
Adult count		1998	= 3,677

Over-wintering kelt survival - 1998 to 1999

with recreational catch removed $\dfrac{(\ 1{,}857\ )}{(\ 3{,}677 - 375\ )} = 56.24\%$

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Upstream migration			
	Tagged	Est. previous Spawners	Total 1999	Percent previous spawners
Small	175	543	3,076	17.64%
Large	71	220	493	44.65%
Total	246	763	3,569	21.37%

Sea survival rates with correction for pervious spawners:

Smolt count for the year	1998	=	50,411
Upstream grilse only count for the year	1999	=	2,533
Previous spawners survival 3 months for	1999	=	41.07%
Corrected sea smolt survival for the year	1998	=	5.03%

Appendix 7
Sea survivial rates for Campbellton River Atlantic salmon (2000)

Sea survival rates for 99 smolt class:

			Year		
Smolt count for			1999	= 47,256	
Adult count	Small =	1,798	2000	Total = 2,006	
	Large=	208			
Sea survival rate from smolt to small salmon			1999-2000	= 3.80%	(uncorrected)

Previous spawners:

Kelts (downstream)	2000	= 1,597	
Tagged kelt releases (downstream)	2000	Total = 627	
(in yr 2000 = 466)			
(in yrs 1994-99 = 161)			
Ratio untagged : tagged (total) kelts		= 2.55	
Recreational salmon catch for	1999	= 288	
Adult count	1999	= 3,076	

Over-wintering kelt survival - from 1999 to 2000

with recreational catch removed = $\frac{(\ 1{,}597\ )}{(\ 3{,}076 - 288\ )}$ = 57.28%

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Upstream migration			
	Tagged returns 2000	Est. previous Spawners	Total 2000	Percent previous spawners
Small	26	66	1,798	3.68%
Large	31	79	208	37.96%
Total	57	145	2,006	7.24%

Sea survival rates with correction for pervious spawners:

Smolt count for the year	1999	=	47,256
Upstream grilse only count for the year	2000	=	1,732
Previous spawners survival 3 months for	2000	=	9.09%
Corrected sea smolt survival for the year	1999	=	3.66%

Appendix 8 (summary)

Mean Sea survival rates for Campbellton River Atlantic salmon 1994-2000

Sea survival rates for 1993-1999 smolt classes combined:

		Years	Total	
Mean smolt count for		1993-1999	= 47,292	
Mean adult count	Small	1994-2000	= 2,746	
	Large		= 333	
Mean sea survival rate from smolt to small salmon		1993-1999	= 5.81%	(uncorrected)

Previous spawners:

Mean kelts (downstream)	1994-2000	= 1,980
Mean tagged kelt releases (downstream)	1994-2000	= 578
Ratio untagged : tagged (total)		= 3.43
Mean recreational salmon catch for	1993-1999	= 347
Mean adult count	1993-1999	= 3,079
Mean over-wintering kelt survival with the recreational catch removed	1994-2000	= 72.49%

The following table is a summary of the estimated numbers of previous spawners in small and large categories:

	Mean upstream migrations			
	Tagged returns 1994-2000	Est. previous Spawners	Total 1994-2000	Percent previous spawners
Small	119	407	2,746	14.81%
Large	60	207	333	62.04%
Total	179	613	3,079	19.91%

Sea survival rates with correction for pervious spawners:

Mean smolt count	1993-1999	=	47,292
Mean upstream grilse migration	1994-2000	=	2,340
Mean previous spawners survival (3 months)	1994-2000	=	30.96%
Mean corrected sea smolt survival - 1993-99	1993-1999	=	4.95%

Appendix 9

STOCK: **Campbellton River (SFA 4)** **Drainage area:** 296 km² (accessible)

CONSERVATION REQUIREMENT: 2.916 million eggs (~ 1,480 small salmon) calculated as fluvial area x 2.4 eggs/m² and lacustrine area x 368 eggs/ha

Year	1995	1996	1997	1998	1999	2000 [2]	MIN [1]	MAX [1]
Total returns to river								
Small	3035	3208	1975	3275	3076	1798	1975	4001
Large	218	560	321	402	493	208	145	560
Recreational harvest (small salmon)								
Retained	393	463	254	375	288	183	23	1547
Released	47	93	67	281	126	48	4	281
Recreational harvest (large salmon)								
Retained	-	-	-	-	-	-	0	63
Released	1	31	9	8	22	5	0	31
Spawners								
Small	2637	2736	1714	2872	2775	1610	1714	3675
Large	218	557	320	401	491	208	145	557
Egg conservation requirement								
% met	279	333	192	315	333	175	192	333
Smolt count	39715	58369	62050	50441	47256	35596	31577	62050
% Sea survival (Adult return year)	6.1	7.2	2.3	4.9	5.0	3.7	2.3	7.2

[1] Min and max are for the period of record since 1974.
[2] Preliminary

Data and methodology: Smolts were enumerated at a counting fence. Returning adult salmon are enumerated at a fish counting fence with a video camera system. A hook-and-release mortality rate of 10% was used in the calculation of spawning escapements for the years 1993-00. Recreational data for 1997-00 were from the License Stub Return System and are preliminary. Sea survival is corrected to exclude previous spawners in the upstream migration. Previous spawners were estimated in 1999 from survival patterns in previous years. Egg conservation requirement met for 1996, 1997,1998 and 2000 was calculated using average percent female and average whole weight, 1993-2000 due to the low number of samples obtained from the angling fishery.

State of the stock: Conservation requirements were met from 1993 to 2000.

Forecast: No forecast available.